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UNIVERSITY OF ALBERTA

A CASE STUDY OF UNIVERSITY-INDUSTRY PARTNERSHIPS

BY

JOSEPH KIPLAGAT KOECH

A THESIS SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

IN

EDUCATIONAL ADMINISTRATION

DEPARTMENT OF EDUCATIONAL POLICY STUDIES

EDMONTON, ALBERTA

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Abstract

The purpose of the study was to explore and describe the perspectives of researchers and administrators on university-industry research and development partnerships based on their participation in these collaborations. The objective was to develop an understanding of these partnerships.

The perspectives presented are on: the initiation and reasons for their participation in these R & D partnerships, the organizational structures, benefits obtained, problems and challenges faced, the nature of the environment, and insights derived from these experiences.

The study adopted an interpretive case study research design utilizing qualitative methods for collecting, analyzing and interpreting data. Semi-structured interviews with these R & D participants provided the data on the perspectives. Relevant documents from the University and participating institutions provided further information that added to a holistic understanding of these partnerships.

The major findings that emerged from this study were:
(a) funding and intellectual curiosity were the major motivating factors for the involvement of University researchers while the search for University expertise, development and transfer of technology from the University to industry were the main reasons for industry respondents; (b) university bureaucracy and time taken to finalize the research agreements were cited as major problems by respondents in both sectors ; (c) some respondents from small companies claimed that they faced stiff competition from large companies for university researchers who they noted tended to be lured for big funds offered by these companies; (d) constant dialogue between university and industry sectors, the presence of "project champions" in industry for these collaborative research projects, increasing the level of awareness of each other and their potential resources, and hence the importance of marketing, were cited as critical to the success of these

partnerships; (e) the need for coordination of R & D activities between the University, industry and government was emphasized.

Suggestions for enhancing these partnerships and the implications of the study for researchers and policy makers are given. University bureaucracy, exploring appropriate organizational structures for collaboration, marketing and reward systems for engaging in these links were some of the key areas that needed to be addressed.

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CHAPTER 1

OVERVIEW AND BACKGROUND TO THE STUDY

Introduction

The challenge for countries to be economically competitive has become intense in recent years. Post-secondary institutions, and especially universities, have come under intense pressure to assist in meeting this challenge. Research and development (R & D) in the universities and industry has come to be considered as one of the most important activities in enhancing a country's economic growth and competitiveness. Whereas it is commonly acknowledged that the main functions of the university are three fold, namely teaching, research and public service (Lajeunesse & Davidson, 1991, p.75; Newson & Buchbinder, 1988, p. 23), and that the three functions should reinforce and supplement one another (Lajeunesse & Davidson, 1991, p.75), in the current context with its focus on international competitiveness, the research and service functions of the university have become central. Fostering university-industry relations in collaborative research and development (R & D) with the hope of enhancing innovations, especially those related to science and technology, is one strategy. Through university-industry partnerships, in the form of joint research and development programs, the two sectors are expected to contribute to the advancement of knowledge and innovation in the production of competitive products, processes and services and ultimately contribute to the welfare of society.

Studies have found that those countries whose pace of development is relatively fast have invested heavily in research and development (Matthews and Norgaard, 1984, p. 20). Japan, for instance, has attracted special interest because of its competitive edge in a number of areas over the United States of America and other western industrialized nations. Matthews and Norgaard (1984, p. 20) further observed that one of the reasons that has

been given for Japan's competitive edge is that it attached high priority to the close cooperation between, government, industry and education. Tietel (1989) noted that this rise of Japan's competitive edge led to closer cooperation between universities and industry in the United States, stating that "economic down turns and the increased sense of competition with Japan have made some companies turn to academia for help in increasing the productivity of their workforce and bringing about more rapid development of new knowledge into marketable applications" (p. 45). Matthews and Norgaard (1984) noted that this strengthening of relationships between industry and academia has been described as a "courtship of necessity" (p. 21) and emphasized the importance of universities as intellectual focal points for high technology industries (p. 47). They further noted that it is no longer sufficient for universities to create knowledge and merely pass it on to students: "Educational programs and institutions are important elements of the economic and industrial infrastructure precisely because they represent a critical link in the transfer and utilization of knowledge throughout society" (p. 47). Citing the Morrill Act of 1862 in the United States as a significant turning point in the development of partnerships between higher education, government and industry, Matthews and Norgaard (1984) noted that " today's concern about strengthening partnerships between higher education and industry has resulted in a call for a high-tech Morrill Act, one that will recognize, like the original Morrill Act, the strategic importance of education" (p. 53).

In recent years, most western industrialized countries, Canada included, have put a lot of emphasis on university-industry collaboration. In 1991, the Government of Canada, in a document on prosperity initiatives entitled *Prosperity through Competitiveness* underscored the important role of R & D in enhancing Canada's competitiveness (p. 42) and called for increased support for university and private sector collaboration (p. 18). Lajeunesse and Davidson (1991, p. 78) further noted that university /private sector research centres continued to emerge throughout Canada in all fields of science and technology. In fact, a May, 1993 report of the Standing Committee on Industry, Science and Technology,

Regional and Northern Development, *Beyond Excellence: The Future of Canada's Networks of Centres of Excellence*, recommended that these centres of excellence establish stronger links with the industrial sector (p. 13).

It is necessary to point out, however, that calls for university-industry collaboration in Canada are not a recent phenomenon. The Science Council of Canada and various federal research committees that have been established over the years, beginning with the MacDonald Commission on "The Role of the Federal Government in the Support of Canadian Universities" in 1969, have advocated the establishment and promotion of these linkages. In 1983, the Corporate-Higher Education Forum was established in Canada to facilitate cooperation between universities and the private sector. This body, comprised of presidents of universities and industrial and business corporations, has undertaken a number of general survey studies on university-industry collaboration in Canada with the intent of stimulating interest in this area. A 1987 report of the Canadian Association of Manufacturers Task Force on Business-Education Relations, entitled *Keeping Canada Competitive: The Importance of Post-secondary Education* , noted the declining competitiveness of Canadian industry (p. 11) and appealed to post-secondary institutions and especially the universities to play a greater role "in the creation of a competitive national economy" (p. 18). The Science Council of Canada (1988) reported that a number of Canadian universities have established offices of technology transfer to facilitate the transfer of technical knowledge from universities to industries. It is apparent from this that some of the universities have responded to the challenge.

It is in the above context that university-industry partnerships and technology transfer have become a focus of attention not only in government circles but in industries and universities as well. Certainly all three are stakeholders in terms of the expected benefits accruing from such ventures. Given that universities are the seedbeds for the creation and dissemination of knowledge, and that industries apply knowledge for profit, governments look to universities and industries to provide leadership in areas of innovation

that will assist them in boosting the country's knowledge base and productivity, leading to superior products and processes and thus to better competition. Facing declining budgets due to dwindling government funding, universities look to industries, alumni and foundations for financial support; establishing partnerships with industries and foundations is one way this can be realized. Establishing these partnerships with industries, foundations and ensuring that they function efficiently and effectively is a challenge for both university and industry researchers and administrators. There is, however, a paucity of research carried out in this area, especially in Canada and, given its current prominence, a study of these partnerships would not only be timely but also necessary.

Background to University-Industry Partnerships

Universities have been described as " ivory towers " due to their perceived aloofness and neglect of societal problems. This assertion is unfair, given that one of the functions of universities has been the production of human power for the development of society. The basis of the assertion arises from the perception that universities have not been as much involved as they should be in addressing practical problems that societies face. It should be pointed out, however, that university-industry collaboration is not a recent phenomenon but has a long history. It has existed since the middle ages and the industrial revolution (Cobban, 1990; Millard, 1991). These relations have been characterized by different degrees of collaboration over time from weak to strong and vice versa, as will be elaborated later. However, in the late 1970s and early 1980s, universities in North America and Europe began to be more involved in joint research projects with industries for the purpose of producing better products and solving societal problems. These interactions have taken many forms.

The following forms, summarized by Low (1983, pp. 71-74) provide a comprehensive view:

Consulting. This involves individual agreements between faculty members and a firm where the faculty members provide consulting services in their field of expertise.

Research grants and contracts. Here the university and a firm make a formal contractual arrangement whereby a faculty member or group of faculty members, and in some cases graduate students, will conduct research in some specified field with some degree of funding will be provided by the firm.

Major contracts. This is a special case where a university enters a multi-year, multi-million-dollar contract with a company to do research in a broad area. Examples given are Monsanto's $23.5 million five-year contract with Washington University to conduct product-oriented genetic research; and Exxon's $ 8 million ten-year agreement with the Massachusetts Institute of Technology (MIT) to do research on combustion methods.

Affiliate programs. This is where companies become "affiliates" of a program, a department, a group of departments, or of the university as a whoie, for a membership fee. The affiliated companies receive a window into the university's research, through mutual visits, conferences, special training programs or short courses and publications. The university receives advice on the needs of the marketplace and may, in response, review its curriculum accordingly. The Massachusetts Institute of Technology (MIT) Industrial Liaison Program is given as an outstanding example, earning about $6 million annually in membership fees from about three hundred firms.

University consortia. This is where a group of universities combine together to focus on a specific problem or a set of problems pertaining to certain areas of interest and concern to industry.

Industry cooperatives. These are cooperative arrangements for dealing with universities that have been formed by companies in an entire industry who perceive a need for more basic research. The US Semi-Conductor Industry Association, which supports centres of excellence and individual research programs, is given as an example of an

industry cooperative. Funding from these companies is distributed to the universities in response to specific proposals.

Exchange of people. This involves exchange of staff between the two sectors. Engineers, scientists or managers from industry go to campus to deliver lectures or work as adjunct faculty while faculty members spend their sabbatical leaves working for a company.

Incubators and research parks. These are research parks established either on campuses or near campuses for joint research projects between the two sectors. Universities have encouraged such ventures by helping new firms, providing them advice, laboratory and library services and often inexpensive space. The North Carolina Research Triangle Park and the Stanford Industrial Park are given as successful cases. In fact the Silicon Valley semiconductor and biotechnology industries owe in part their success to the Stanford University Industrial Park.

Maxwell and Currie (1984, p. 2) have outlined eight main forms of corporate-university collaboration based on their survey of the Canadian scene as: (a) University-based interface institutes; (b) Joint ventures; (c) Contract research; (d) University-based research park; (e) University -based companies; (f) Cooperative education; (g) Continuing education; and (h) Personnel transfer programs.

The initiation and operation of these partnerships have, however, been beset with problems. Melchiori (1983, p. 11) summarized the following problems or barriers to more and better partnerships: (a) questions of patent rights and licensing: who is entitled to do what and get what after the invention of the product; (b) institutional differences between universities and industries in organizational behavior norms and processes; (c) loss of academic independence by universities "nothing is more feared in colleges than the danger of losing or compromising academic values and goals in order to attract commercial funds" (Melchiori, 1983, p. 11); (d) proprietary rights--who holds the proprietary rights of the

invented product? Who is the licensor? Should the university or industry manufacture the product?

As a result of problems such as these, not all university-industry partnerships have been successful (Matthews & Norgaard, 1984, p. 7). Matthews and Norgaard (1984, p. 99) pointed out that the existent organizational structures in universities have been obstacles to the smooth functioning of partnerships. They, therefore, called for concerted efforts to make the best out of them, saying that "because of success in past partnerships, the focus now is not whether to form partnerships ... we wish to know how to make the best of them" (p. 4). They observed that partnership at the individual levels have been successful but hampered by administrative structural obstacles:

> Partnerships seem easy at the grass-roots level. You sit down with a faculty member or executive, you define the problem, you shake hands, and go out and do it. But when lawyers, sponsored research offices, and other administrators become involved, the complications grow exponentially. (p. 76).

They further noted that "the most frequent obstacles tend to be bureaucratic structures unresponsive to the new needs presented by these alliances" (p. 98) and pointed specifically to "the outmoded structures of university administrations" (p. 98) as a major obstacle. They indicated that many universities have not been equipped to handle these linkages and that all of the partnership structures that have been established have been *ad hoc* (p. 99). They called for appropriate structures of collaboration, pointing out that "innovation will be squeezed if industry and academia don't cooperate and instead retain the status quo in outmoded organizations, policies and procedures" (p. 117). Weaver et al. (1989, p. 165) noted that " the determinants of entrepreneurial activity depend not only on individual factors (personality characteristics, values and behavior orientations) but also on organizational characteristics that support and facilitate entrepreneurial activity and the extent to which resources are made available " (p. 165). Fairweather (1988, p. 50) observed that the academic departmental structures have been created for teaching purposes and are, therefore, not suited for research liaisons. As a result, other structures such as

organized research units have been created. Similarly, Rebne (1989) noted that " although important issues such as academic freedom and intellectual property rights are far from resolved ... for many policy-makers, the area of university-linkages is now more a matter of developing effective mechanisms than one of questioning the basic mission" (p. 339). Commenting on the Canadian scene, Buchbinder and Newson (1990, p. 368) noted that academic senates (General Faculties Councils in some universities) have rarely been involved in deliberations on university-corporate linkages because the university administrators are afraid that these senates will oppose such moves. Clearly, then, from the above statements, it seems that one of the major challenges facing university-industry linkages is organizational. This study set out to explore the organizational features and relationships as well as problems and challenges that these partnerships face. Given the importance of this area of endeavour, as expounded in the preceding sections, it is necessary that the perspectives and experiences of those involved be studied.

Purpose of the Study

The purpose of this study was to develop an understanding of university-industry R & D partnerships by describing and explaining the structures, processes, problems and challenges facing these partnerships. The following objectives guided the study: (a) to develop an analytical description of the nature of partnerships between a specific university and industry, and (b) to develop an analytical description of the nature of two selected partnerships between the university and industry. The study consisted of two phases. The purpose of the first phase was to obtain the general picture of the interactions between the university and the private sector. Phase two was a detailed examination of two selected partnerships (their motivations, organization, coordination and management, benefits, problems and challenges) . Given that this was an exploratory study, it was important to ascertain the nature of these collaborations, what forms they took, and to explore the

experiences of those who were involved in these interactions in both the university and industry sectors.

The research was guided by the following questions?

1. What partnerships existed and what forms did they take ?
2. Why were they established (motivations) and how were they established (processes)?
3. How are they organized and managed (structures and processes)?
4. What problems, issues and challenges do they face?
5. What have been the outcomes of these partnerships?
6. What lessons were derived from participating in these partnerships?
7. How can these partnerships be enhanced?

The Significance of the Study

This study has a number of significant contributions to the field of university-industry relations. These are examined from the following contexts: contribution to research in this field in general, contribution to research in the Canadian national context, contribution to research in institutional context, and contribution to policy, organization and administration of these university-industry research and development partnerships.

Contribution to Research on University-Industry Partnerships

It was noted in the preceding sections of this chapter that although the field of university-industry partnerships has a long history, its re-emergence and emphasis is a fairly recent phenomenon. It was expected that undertaking this study would, therefore, contribute to the field of knowledge in the area of university-industry relations. In fact, Crespo (1991, p. 27) and Cerych (1989, p. 310) have noted that there have not been many studies done in this area. Cerych (1989) emphasized this point when he said, "In spite of a large number of reports and papers prepared and published since the early 1980s on university-industry relations, there is relatively little social science research in this area"

(p. 310). It was anticipated, therefore, that an in-depth study of this nature would provide more information in this field and stimulate further interest among scholars for more research, given its recent emergence and importance. Recently, Andrews (1992), while discussing the challenges facing post-secondary education, called for further exploration of partnerships between post-secondary institutions and industry (p. 25). Similarly, Prosser and Cerych (1992) expressed the need to assess the successes and failures of these university-industry interactions over the years stating that "what we believe is of greatest interest is to assess the experience accumulated over the past period, the lessons which can be drawn from this experience, to evaluate the extent to which expectations were or were not met and to identify future prospects" (p. 321). They further pointed out that despite past studies in the area, "our understanding of the process of higher education-industry cooperation remains poor..." (p. 321). It was believed that by exploring and expounding on the experiences of those involved in these collaborative activities, some of these expectations and goals would be achieved.

Contribution to Research on University-Industry Partnerships in the Canadian Context

Further, it was anticipated that the study would contribute to a data base that could be used by those interested in comparative studies in university-industry relations. A 1990 Association of Universities and Colleges of Canada document, "Trends: The Canadian University in Profile," pointed out the concern by some in the university community about "too many strings being attached to most business funding" and other forms of funding (p. 8) as well as questions of threat to university autonomy (p. 9). Similar questions and related concerns on the effect of university/business relations on university governance, university autonomy, and basic and applied research are addressed by the Canadian Association of University Teachers' University Governance Commission (February, 1991). This study does indeed bring out how some of the issues raised above are being addressed by both sectors.

Contribution to Research on Partnerships between the University of Alberta and Industry

The University of Alberta, like any other university in North America, fulfills the three main functions of teaching, research and public service. Since the establishment of the Office of the Vice-President (Research) in July, 1981, the University of Alberta has continued to pursue collaboration with the private sector. This office was established "in order to improve support for the research efforts of faculty and to promote the transfer of discoveries and innovations to industry and the community" (Enros and Farley, 1986, p. 38). The University's interest and efforts in collaborative activities with industry is further evidenced by the following sequence of events: the establishment of the Office of Research Services in 1982; the appointment of its director from industry in 1983 with the mandate "to develop closer links between the private sector and the university"(1982/83 B.O.G. Report, p. 9); the establishment of the first formal technology transfer position within the Office of Research Services in 1985; and the creation of the Intellectual Property and Contracts Office in 1990. Over the years, the University of Alberta established a number of research centres and institutes where University and industry researchers carry out collaborative research. Further, a number of spin-off companies have been set up as a result of research emanating from the University with the purpose of putting into effect the transfer of technology from the University to the private sector. June, 1993 response by the University of Alberta to The Royal Society of Canada report, *Realizing the potential: A strategy for university research in Canada*, supported the Society's call for further studies on university-industry collaboration (p. C-18). By examining the perspectives and experiences of those involved in the university and industry sectors, such a study would provide an opportunity for the University to reexamine its program in this area with a view to further enhancement.

Contribution to Policy, Organization, and Administration of University-Industry Partnerships

This study has both theoretical and practical value. Given the importance attached to university-industry relations for achieving the benefits that are expected to accrue from such relationships, it is fitting that further research be done on how these partnerships evolve and function and what factors contribute to their success. The study will also provide insights into the nature of these relationships and any problems that may be associated with them. Such findings should be of interest to university administrators and researchers about how best to organize and benefit from these linkages and what precautions need to be taken. The perspectives of those involved in collaborative ventures should guide policy makers and administrators in government, the university and the private sector in addressing the concerns and aspirations of those affected and, hopefully, lead to a better understanding of these relations and consequently to better organized and managed partnerships. Certainly those universities that are contemplating initiating such partnerships will be interested in the experiences of those partnerships that are already in operation. From the perspective of the researchers, how has their participation in these linkages enhanced their innovativeness and that of their students, as well as their teaching programs? In the same vein, then, the study has policy implications for the organization and management of these linkages.

It has already been noted that several government and university documents have called for increased collaboration in research and development between the universities and the private sector (for example, Canada at the Crossroads, 1991; Prosperity through Competitiveness, 1991; Realizing the Potential: A strategy for University Research in Canada, 1991). These reports are definitely an indication that this type of study is both timely and significant. It is evident from what has been discussed so far that universities have good reasons to be involved in collaborative research with industry. Apart from the accrued benefits outlined, society benefits from the outcome of joint research with industry.

Despite the benefits, however, issues of patent rights, proprietary rights/intellectual property rights, appropriateness/inappropriateness of university structures, academic and institutional freedom appear to be too major to be ignored and have, indeed, far-reaching implications for the future of these linkages and thus the significance of this study.

Assumptions

In undertaking this study, the following assumptions were made:

1) that the conceptual framework (p. 39) provided a useful starting point for exploring some of the dimensions of university-industry linkages;
2) that the administrators and researchers who were interviewed possessed the necessary information required for purposes of this study and that they would feel free to share this information, even that which is critical of partnerships;
3) that a case-study design, using semi-structured interviews and document analysis, was an appropriate method for the purposes of this inquiry;
4) that university-industry partnerships provide a positive contribution to both sectors and society at large; and
5) that the study will make a contribution to the field of knowledge on university-industry relations.

Delimitations and Limitations

The university has many activities relating to interactions with industry which the study could not cover. The study was therefore delimited to the following:

1) One western Canadian university was selected for this study of university-industry in research and development;
2) University researcher interviewees were mainly drawn from the engineering, sciences, and medical fields since that is where most of the collaborative research interaction with industry took place.

3) The study was also delimited to detailed examination of two selected partnerships as case examples (their motivations, initiation, organization, benefits, related problems, and challenges pertaining to linkage operations).

The following two selected partnerships were selected:

(a) a major university-industry collaborative research agreement between the University and an Edmonton-based firm;

(b) the R & D interactions between the University and a University-industry consortium in which the University of Alberta was co-founder.

4) Interviewees were drawn from those who had primary involvement in these partnerships.

This study was limited by the following factors:

a) This study brings out only the perspectives and experiences of those who were involved in university-industry R & D collaboration, and these people tend to be advocates for university-industry cooperation.. However, as has been noted, opponents of these interactions exist in both the industry and the university sectors. Perceptions of those who may be opposed to these collaborations is, therefore, lacking.

b) The study was also limited by the extent of the knowledge and ability of the respondents to recall their experiences and verbalize them succinctly.

c) In qualitative research a lot data is generated and the researcher has to decide what to include and not to include in the research report. The researcher may therefore have left out some of the information that may have added to the quality of the report.

Definition of Terms

Linkages (collaboration, interactions): These are arrangements which bring the university and corporation into cooperative action to advance their shared interests.

Partnerships: are formalized, legal set of arrangements laid out in a written agreement whereby the university and a company or companies enter into a joint venture with each contributing some specified value to the common enterprise and each hoping to obtain some benefits.

Industry: This term is used in reference to a business or a corporation that is involved in the production or research and development of goods and services.

Research and development [R & D]: This refers to the generation of knowledge and ideas and their application or translation to improve or produce new products and processes or services.

Technology transfer: This refers to all the activities that are carried out in the linkages or partnerships referred to above but geared towards the transfer of technical know-how and research results, and the successful utilization of technological resources (knowledge, expertise, facilities and actual technological developments such as development of patents) from universities to the industry/corporate sector.

Research grants: These are funds awarded to individual researchers or groups of researchers or to the institution on their behalf by industry, government or other agencies to support research of particular interest to an individual, groups of individuals or a department.

Research contract/agreement: This is an agreement whereby the sponsor undertakes to purchase a specific research service or expertise under certain specified and negotiated conditions.

University spin off company: This is a company that has been established to produce a product or service emanating from research in a university.

Small Companies: In the context of this study, small companies refers to those companies with 100 employees and less. However, respondents also used the term to describe themselves when comparing themselves to much larger companies.

Organization of the Thesis

This chapter has provided an introduction and background to the study. A brief historical evolution of university-industry interaction over the years was presented as well as the different forms that these partnerships take. The justification and the significance of study and, the delimitations and the limitations of the study are also provided.

Chapter 2 contains the literature review on university-industry collaboration, its historical development in the United States and Canada, in particular. The different forms that these partnerships have taken, the benefits, the problems and the challenges they face are explored. Similarly, some salient concepts in the interorganizational theory literature are explored. Chapter 3 is a description of the research design and the methods used in collecting and analyzing the data for the study. In chapter 4, background information on the University and the collaborating organizations is provided. This includes a description of the current partnership activities and their organization.

Chapters 5 and 6 provide the perspectives and experiences of the University and industry interviewees who were involved in collaborative R & D. Their perspectives and experiences on various aspects and dimensions (motivations, benefits, environment, problems, challenges and lessons) are explained. Chapter 7 describes two partnerships selected for detailed study. Chapter 8 contains the synthesis, analysis and discussion of the findings of the study. Chapter 9 provides the summary, reflections, conclusions and recommendations.

CHAPTER 2

REVIEW OF RELATED LITERATURE

This chapter presents a review of the pertinent literature. The purposes of this review are as follows:

1) to introduce some of the issues, perspectives and concepts pertaining to university-industry partnerships that assisted the researcher in terms of a preliminary orientation to the study of the subject, i.e. helped to initiate the qualitative exploration by suggesting possible interview questions or foci.

2) to introduce some of the issues, perspectives and concepts pertaining to university-industry partnerships that are relevant to understanding the themes and categories that emerged from the perspectives shared by the research participants.

The review is developed in three parts:

1) the first part is an overview of the historical evolution of university-industry collaboration, thereby providing a useful contextual background to the subject being researched;

2) the second provides a conceptual understanding of partnerships by describing various forms of collaboration, and examining what the literature on organizational theory and interorganizational linkages has to suggest about such partnerships;

3) the third presents an overview of the major issues (motivations, problems, challenges and lessons) facing such partnerships.

University-Industry Relations: Historical Perspectives

University-industry relationships have existed for decades through connections between individual researchers and industrial partners and through the role of universities in training students and upgrading of employees (Crespo, 1988, p. 1; Kells, 1989, p. 1). Kells (1989, p. 1) noted, however, that the institutionalization of these relations is an

aspect that is fairly recent. Since their inception, universities have been expected to serve societal needs. As Cobban (1990) stated, " Far from being esoteric ivory towers, the medieval universities were expected to give value for money by responding to the vocational needs of society" (p. 32). Reinforcing the same, Matthews and Norgaard (1984) noted that relationships between higher education and industry have a long history, stating that "what has changed over the course of time is the basis, purpose and the extent of these partnerships "(p. 53). They further reported that the extent of university-industry relations decreased after the middle ages and it was not until the Second World War that these relationships picked up again.

In the United States, the Morrill Act of 1862 is regarded as a significant turning point in university-industry collaboration. Commenting on this act, Matthews and Norgaard (1984) noted that "this legislation established the land-grant university system and provided the basis for partnership between higher education, business and the government in the fields of agriculture and the mechanical arts"(p. 53). The Russian advancement in space science and the successful launching of the Sputnik in 1957 spurred the United States to emphasize science and education and to encourage universities and industries to work together in aerospace and defense research (p. 20). Matthews and Norgaard (1984) reported that by the end of the 1960s, universities and industries had parted ways. It was, however, the economic competitiveness of Japan and other western industrialized nations that forced the United States to re-emphasize the importance of close collaboration between universities and industry. Collins and Tillman IV (1988), for example, observed that the interest in university-industry relations developed again in the 1970s when it was realized that

> basic technologies produced by the universities in the 1970s lay largely underdeveloped by the American companies and often were commercialized by foreign firms, especially the Japanese companies. To correct this, the Government, industry, and academia began to form new partnerships designed to focus on research with apparent commercial promise and to minimize barriers to the expedient transfer of results. (p. 22)

Collins and Tillman IV (1988, p. 23) further noted that the United States federal government through the National Science Foundation sponsored the establishment of innovation centers across the nation to foster these collaborations. They also noted that in the 1980s the federal patent policy revisions allowing universities to retain ownership of patents based on federally funded research increased the number of technologies available for commercialization. It should be borne in mind, however, that the growth and interest in university-industry relations were not restricted to the United States but were also found in Europe and Canada as well.

The Canadian Scene

Schneider (1978, p. 15) noted that until the 1950s, there was excellent cooperation and collaboration among researchers in universities, industry, and government laboratories in Canada. Enros and Farley (1986, p. 12) reported that, as far back as 1900, the Canadian Manufacturers Association was calling for links between business and higher education. They noted that during that period a number of universities established links with industry and cite McGill University in 1904 and Queens University in 1919 as examples. Schneider (1978, p. 15) also stated that the interactions between the two sectors was quite high during the years of World War II. This is similar to what occurred in the United States during the same period. Newson and Buchbinder (1988, p. 78) noted that, after World War II, Canadian business played an important role in the development of new universities by providing funds as well as by being centrally represented on the university boards of governors. Schneider (1978) further reported that in the 1950s and 1960s "there was a dramatic change and university research and industry research largely tended to become separate solitudes" (p. 15). He noted, however, that by the late 1960s, the National Research Council initiated a number of programs designed to enhance university-industry research cooperation (p. 16). Since then the Federal Government through the Research Granting Councils, namely, The Natural Sciences and Engineering

Research Council (NSERC) and the Medical Research Council (MRC), have initiated various programs to boost cooperation between the two sectors. Newson and Buchbinder (1988) attributed the increase in Canadian university-corporate relations to the federal and provincial fiscal retrenchment from 1970s stating that

> enthusiasm for renewed cooperation between academe and business has arisen in large measure as a response to this crisis. Private sector funding may ease fiscal pressures, and universities with high-powered research and training, can assist Canadian technological and industrial initiatives for the next century. (p. 8)

Corporate-Higher Education Forum

The establishment of the Corporate-Higher Education Forum in 1983 marked a turning point and gave a boost to university-corporate initiatives (Maxwell & Currie, 1984). As was noted earlier, the Corporate-Higher Education Forum was established in 1983 to foster cooperation between universities and the corporate sector. The first product of the Forum is contained in a document entitled *Partnership for Growth: Corporate-University Cooperation in Canada* (1984). In this document, Maxwell and Currie (1984) summarize the findings of a survey of corporate-university cooperation in Canada then, the perceived motivation and benefits, and recommended a plan of action for the two sectors as well as for the Forum itself. The study found that different forms of corporate-university cooperation existed in the country but were unevenly distributed and mainly to be found in the eastern part of Canada, noting that "despite recent growth in activity, collaboration is not evenly distributed, even among universities with strong commitment to research or the natural sciences and engineering"(p. 3). They noted that despite a lack of accurate statistics on the level of university contract research with industry in Canadian universities, it was "generally recognized that industry-sponsored contract research with industry has been growing over the last decade"(p. 50). Further, the survey identified two major barriers to collaboration, namely, the cultural differences between the two sectors and inadequate managerial resources for these partnerships (p. 3).

The second study by the Forum's Task Force, established in 1984, is contained in a document entitled *Spending Smarter: Corporate-University Cooperation in Research and Development* (Cyr, 1985). In this study, based on a survey of corporate and university leaders as well as university researchers, the following findings emerged: (a) there was inadequate marketing by the universities of their research expertise and thus corporations did not know what the universities had to offer; (b) foreign companies provided more support to Canadian universities than Canadian companies; (c) there was commitment made by some of the corporate and university forum members to initiate various activities in their institutions to foster corporate-university links.

The Science Council of Canada Initiatives

Since 1981, the Science Council of Canada has examined the relationship between university and industry in a number of publications. Gilmour (1986) noted that "the growing interest in the links between the ivory and office towers prompted the Science Council in 1984 to undertake a major study on the subject from the perspective of making the university a more effective contributor to the Canadian economy" (p. 5). He pointed out, further, that it was not the Council's intention "to act as an authority but as a consultant and catalyst by raising those issues important for science and technology policy and having them discussed"(p. 5). Enros and Farley (1986, pp. 9, 18, 19) noted that the proliferation of offices of technology transfer in the universities from the beginning of 1980s was an indication of the significance that Canadian universities attached to interaction with the private sector. Newson and Buchbinder (1988) noted that the term "Service University" coined by the Science Council of Canada brought together the two central thrusts of the two visions of the university: promoter and guardian of academic achievement at the highest level and instrument of high -tech corporate development" (p. 66). They noted that "the mission of the service university to aid in economic recovery and growth is rooted in the commercialization of research, a process already under way" (1988, p. 81). They pointed out, however, that the idea of the service university is "deceptively compelling." While

agreeing with the view that universities should serve the needs of society, they criticized this concept, remarking that "Service means a narrow, unidirectional focus on satisfying the needs of the corporate sector, rather than a broad focus on the diverse needs of the Canadian society as a whole. Service to society is equated as service to industry" (p. 82).

The 1987 Higher Education Forum

The National Forum on Post-Secondary Education, held in Saskatoon in 1987 to explore the challenges and opportunities facing Canada's universities and colleges in preparation for the 21st century, also emphasized the need for development and strengthening of cooperation between universities and the private sector. The forum sponsored by the federal government (the Department of the Secretary of State) and the Council of Ministers of Education of Canada (CMEC), was attended by representatives from the universities, the private sector, and the government. In a document entitled *Canadian Universities: Investing in the Future*, prepared for the above Forum, the Association of Universities and Co'leges of Canada (AUCC) noted that the overall frequency of university-industry interaction remained low but pointed out that "in order to make optimum use of human and material resources and to foster effective technology transfers, growing emphasis has been placed on the development of synergistic relationships between university and industry in applied research and development" (AUCC, 1987, p. 31).

The 1990s and Beyond

In the 1990s issues on university-corporate relations continued to be discussed. The results of a 1991 report commissioned by the government of Canada and the Business Council on National Issues and published under the title *Canada at the Crossroads: The Reality of a New Competitive Environment*, made the following observations about research and development in Canada: that the level of R & D expenditures by Canadian industry was low; that the creation and adoption of new technologies had been slow; that

collaborative links between the higher education sector and industry were not well developed, pointing out that "links between universities and industry have been weak, although there have been positive developments in recent years"(p.196); and that "universities, on the whole, are perceived as not very receptive to overtures by industry" (p. 196). Cutt and Dobell (1992, p. 1) reiterated the important role which Canadian universities will be required to play both now and in the coming decades. They stressed that

> higher education and research are moving to the top of public policy agendas in all industrialized countries, as recognition grows that national success in an era of global competition will depend more and more on highly trained labour forces, scientific research and development, diffusion of information, and entrepreneurial information. (p. 1)

In a 1994 document, *Partnership in Knowledge: Maximizing the Investment in University Research,* NSERC declared that as part of its 1994-1998 strategy, it

> will foster stronger links between university researchers and Canadian companies by providing university researchers with information regarding relevant opportunities and research needs in industry. The Council will also create mechanisms through which industry can easily obtain information about new research developments and capabilities within universities. Early contact between the sectors will be encouraged in order to reduce the "commercialization gap" in the transfer of new ideas and technology. (pp. 8-9)

Noting that small and medium-sized Canadian companies' lack of information, capital, human resources and the necessary scientific and engineering research infrastructure often limit their involvement in research, NSERC affirmed that it will place special emphasis on encouraging their participation in its NSERC programs (p. 9). NSERC noted further that "university reward systems, especially for tenure and promotion, may have limiting impact on the activities undertaken by faculty researchers [and] will encourage universities to give more recognition to outreach activities such as interaction with industry and professional associations" (p. 10). It would appear that university-corporate relations will continue to occupy a central place in both the corporate and higher education sectors and in the national arena.

Forms of University-Industry Collaboration

An examination of the literature on university-industry collaboration reveals different categorizations of these collaborations . Low (1983), for instance, provides a different categorization from that of Zinser (1985). As was summarized in Chapter 1, Low (1983) had the following categorizations: (a) consulting; (b) research grants and contracts; (c) major contracts; (d) affiliate programs; (f) university consortia; (g) industry cooperatives; (h) exchange of people; and, (j) incubators and research parks (pp. 71-74).

Zinzer (1985) on the other hand has provided a summary of categories that these activities fall into, listing them from the most distant connection (numbers 1 and 2) to the most institutionally intimate (numbers 5 and 6). These categories are summarized as: (a) *Contributions (philanthropy)* : involving mostly unrestricted financial and material assistance to universities from the corporate sector except in some cases where the funds are for targeted projects such as endowments, construction, endowed chairs or professorships, student scholarships, etc.; (b) *Procurement (purchases)* : includes contracts for specified goods or services such as product testing or access to university labs for other development purposes; (c) *Linkages*: are arrangements made through the sponsored program offices, which essentially provide information about and coordination between faculty and laboratory resources and company needs; (d) *Exchanges*: involve trade of assets (tangible or intangible), such as technology licensing programs or industry affiliate programs, whereby the company pays a fee to get a "window" on the university's technological progress; (e) *Cooperative ventures*: specific involvements with clearly predefined money and benefits for each party. Many research agreements fall into this category, either through one-to-one relationships or through research consortia. (f) *Partnerships:* In these arrangements universities and companies shares potential profits and losses. These arrangements usually take one of two forms. The first involves partnerships with established companies. The goals of a joint partnership are not only to provide long term funding, quick technology transfer, and return on investments to the participating

companies but also to provide a significant financial return on the companies' commercial activity with the universities. In the second form, the university goes directly into business.

Praeger and Omenn (1980) provided the following four main categories of university-corporate relationships: (a) Corporate contributions to the university; (b) Procurement of services; (c) Cooperative research; and (d) Research partnerships. As was reported in Chapter 1, Maxwell and Currie (1984, p. 2) outlined these eight main forms of corporate-university collaboration: (a) University-based interface institutes; (b) Joint ventures; (c) Contract research; (d) University-based research park; (e) University -based companies; (f) Cooperative education; (g) Continuing education; and (h) Manpower transfer programs.

Maxwell and Currie (1984) summarized the definition of contract research and grant sponsored research used by the University of Waterloo. They defined contract research as:

> An agreement providing financial support for an investigator working in a particular field under specific stipulations and conditions as specified in the contract. These specifications and stipulations may specifically outline the scope and the nature of the research to be carried out, together with such matters as patent and publication rights, timing, student participation and confidentiality. (p. 50)

They defined grant-sponsored research as

> financial support for an investigator working in a particular field without any formal detailed stipulations as to the subject matter of such research. Investigators are free to discuss their work with their colleagues and to publish their findings and interpretation of them. (p. 50)

Matthews and Norgaard (1984) described a consortium as an entity that "represents a mechanism whereby a single university can involve a number of companies in its research program. Member companies pay a fee to support university research activities and supply participants to help in that research"(p. 152).

Despite the different categorizations presented above, it appears that the most intimate, as explained earlier, are those that involve deeper commitments in research. This

study will focus on collaborations between the two sectors that have been concluded through formal agreements and particularly those that involve research and development activities.

Major Partnership Issues

Before highlighting the challenges and problems reported to be facing university-industry partnerships, a brief look at the factors that motivate their establishment should serve as a necessary background.

Motivations for Partnerships

Factors that motivate universities and industries to establish partnerships can be examined from the perspectives of the two sectors. According to Matthews and Norgaard (1984, pp. 7-80), Melchiori (1983, p. 7), and Fairweather (1988, p. iv), the following factors motivate universities to collaborate with industry: (a) industries serve as new sources of funds that support faculty and graduate student research; (b) industries serve as new sources of equipment for research and teaching; (c) academics get exposed to the real world of research through access to industrial laboratories and use of more advanced instruments in industrial settings; (d) there is expected income from patent rights arising from discoveries as a result of joint research projects; (e) these serve as alternatives to dwindling government research funds.

On the other hand, the incentives that motivate industry to collaborate with universities, according to Melchiori (1983, pp. 9-10) and Matthews and Norgaard (1984, pp. 107-118), are: (a) they assist industry in acquiring trained personnel from universities which train them for industry (industry support for universities is, therefore, a matter of self-interest); (b) universities are windows on new science and technology, universities being the seedbeds for new ideas and innovations leading to marketable products; (c) the access to university facilities (libraries, entire clusters of related experts and interdisciplinary thinkers) provides industry researchers with ideas and solutions to

research problems; (d) increased productivity for industry arising out of better quality education in the universities and interactions between industry personnel and the university.

Challenges and Barriers to Partnerships

Despite the incentives stated above, it has also been noted that there are a number of barriers to research partnerships between universities and industry. Melchiori (1983, pp. 11-12) and Matthews and Norgaard (1984) discussed these barriers, as expounded below.

1) **Questions of patent rights and licensing.** The basic question here is: Who is to own the outcome of the joint research project? The issue of intellectual property rights comes to the fore. Melchiori (1983) noted that "universities have increasingly objected to having corporations 'pick up and run' with their inventions" (p. 11).

2) **Proprietary rights.** Who holds the proprietary rights to the invented product ? Does the discovery lead to one sales item or to several? Who is the licenser? Should the university or industry manufacture the product or should some other body do it ?

3) **Loss of academic independence by universities.** Matthews and Norgaard (1984, p. 37), Melchiori (1983 , p. 11), and Fairweather (1988, pp. 9, 47) have pointed out that with funding of joint research projects, opponents of university-industry relations fear that industries will use their monetary power to influence the direction of the universities and their programs. One of the issues related to this is the publication of research results. Whereas the academics may want to publish research results for the wider scholastic community, industry would prefer to delay publications and maintain some secrecy until such stage that the publication will not jeopardize the patenting of the product (Melchiori, 1983, p. 13; Matthews and Norgaard, 1984, p. 87; Crespo, 1990, p. 29; Cerych, 1985, p. 16; Fairweather, 1988, p. 9).

Newson and Buchbinder (1988) noted that university-corporate relations have a price pointing out that "faculty members are expected to serve as potential 'spouses' to corporate partners. Teaching becomes a lesser priority in the allocation of resources, both

financial and human. University objectives become skewed towards sellable applications" (p. 74). Leslie (1980) in a AUCC document, observed that

> the mercenary character of contract research, however, is easily overstressed. It is not necessarily trivial or scientifically vapid. The sealing of sweet research deals is not like marrying for money; the behaviour of the scientists on the lookout for contracts may be more akin to seeking out the company of rich women and marrying for love. Only the passionate scientist knows for sure. (p. 171)

4) **Institutional differences between universities and industries.** The focus here is on the differences in organizational behavior norms and processes. Whereas industry emphasizes the maintenance of strict short deadlines, academic research takes more time (Melchiori, 1983, p. 11; Matthews and Norgaard, 1984, p. 98).

5) **Lack of flexibility in university structures.** Cerych (1985, p. 16) noted that in industry everything is organized to solve problems rooted in a broad range of varied but interconnected areas, whereas higher education institutions are organized by disciplines between which there is often little communication. Matthews and Norgaard (1984) observed that "a major obstacle to more fruitful alliances between business and industry remains the outmoded structure of university administration" (p. 99). Fairweather (1988, p. 50) observed that the academic departmental structures have been created for teaching purposes and are, therefore, not suited for research liaisons. As a result other structures such as organized research units have been created.

It is evident from what has been discussed so far that universities have good reasons to be involved in collaborative research with industry. Apart from the accrued benefits outlined, society benefits from the outcome of joint research with industry. Despite the benefits, however, issues of patent rights, proprietary rights/intellectual property rights, appropriateness/inappropriateness of university structures, academic and institutional freedom appear to be too major to be ignored and have, indeed, far reaching implications for future partnerships between these institutions.

Concepts and Dimensions of Partnerships from Organizational and Interorganizational Theory

Since university-industry partnerships involve interactions between the two sectors, the researcher considered it appropriate to search for concepts from the organizational and the interorganizational relations theory literature that might aid in understanding the partnerships studied. This section, therefore, explores some important concepts in this area that may be useful in understanding university-industry partnerships.

Organizations as Open Systems

Morgan (1986, p. 45) noted that classical management theorists treated organizations as 'closed' mechanical systems and focused mainly on principles of their internal design. This view perceived organizations as closed entities capable of rationally pursuing goals and immune to external forces. This perception of organizations came under criticism in the 1950s starting with the work of Von Bertallanffy (1957), Emery and Trist (1960), Katz and Kahn (1966), Thomson (1967), Schein (1970), and Hall (1977) who emphasized the significant role of the external environment in the life of organizations and thus initiated the development of open systems theory of organizations. On the 'closed' system focus of organizations, Emery and Trist (1960) stated that

> there has been something of a tendency to continue thinking in terms of 'closed' system, that is to regard the enterprise as sufficiently independent to allow most of its problems to be analyzed with reference to its internal structure and without reference to the external environment. (p. 78)

The criticism of this traditional conception of organizations led to the systems theory of organizations. Open systems are systems that receive inputs from the environment, transform some of these inputs and send them into the environment as outputs. Inputs include capital, energy, materials, information, technology and people, while outputs include different products and services (Johns, 1988, p. 537). The major focus or emphasis of systems theory was the effect of the external environment on

organizations. This point was underscored by Schon (1970) who remarked that

> the most important argument for a systems conception of organization is that the environment within which organizations exist is becoming increasingly unstable. With the rapid growth of technology, the expansion of the economic markets, and the rapid social and political change , come constant pressures for organizations to change, adapt, and grow to meet the challenges of the environment. (pp. 104-105).

Johns (1988) indicated the importance of examining organizations from an open systems perspective, noting that "the value of open systems [thinking] is that it sensitizes us to the need for organizations to cope with the demands of the environment on both the input and the output side" (p. 538).

Morgan (1986) outlined some of the salient features of the open systems approach to organizations that need careful considerations, namely:

1) In organizing, focus should be placed on the environment in which organizations operate; cognizance should be made of the organization's task environment, which is the organization's direct interactions, such as with its customers, competitors, suppliers, government agencies, and the general environment. He pointed out that this consideration has important implications for organizational practice, in that "the importance of being able to scan and sense changes in the task and contextual environments, of being able to develop appropriate strategic responses" (p. 45) is critical.

2) He further emphasized the need to focus on organizations in terms of their interrelated subsystems, within and without, and "the importance of being able to scan and sense changes in the task and contextual environments, of being able to bridge and manage critical boundaries and areas of interdependence and of being able to develop appropriate strategic responses" (p. 45). Universities as social institutions are considered as open systems (Seymour, 1988, p. 7).

Interorganizational Relationships

Van de Ven (1976) defined an interorganizational relationship as a social action that occurs "when two or more organizations transact resources (money, physical facilities, and

materials, customers or client referrals, technical services) among each other" (p. 24). This is done through the creation of structures and processes which will allow the cooperating organizations to achieve the desired goals and yet maintain their independence. Van de Ven (1976) defined structure as the "administrative arrangements established to define the role relationship among members" and process as "a flow of activities; i.e., the direction and frequency of resources and information flowing among members" (pp. 25-26). In addition to the resources described by Van de Ven (1976) above, Aiken and Hague (1968, p. 588) included the need for specialized skills and access to particular kinds of markets as the other reasons why organizations enter into relationships. Hasenfeld and English (1977) emphasized the study of interorganizational relationships

> in order to understand the conditions that lead to the emergence of relations between organizations, to become sensitive to the consequences of these relationships on interorganizational structures, processes, and clientele and to become aware of the forms of linkages which effectively join organizations to each other. (p. 540)

Hall et al. (1977) pointed out that being aware of the forms of linkages that join organizations or parts of organizations will permit an organization to better anticipate the consequences of the relationships and develop or change its organizational structure to improve these relationships. It is noted that exchange theory has been the dominant theoretical perspective in the study of interorganizational relationships (Levine and White, 1961; Hall, 1977; Van de Ven, 1976; Ratsoy, 1980). Levine and White (1961) defined exchange as "voluntary activity between two organizations which has consequences, actual or anticipated, for the realization of their respective goals or objectives" (p. 588). Securing of resources, reduction of uncertainty and control over the environment are some the reasons considered for interorganizational relations. It is also noted that another reason for the development of interorganizational relationships is the attainment of goals which would not be possible to achieve independently by these organizations (Levin and White, 1961; Van de Ven, 1976; Ratsoy, 1980). While the basis of some of the

interorganizational relationships are voluntary, others are mandated by legislation or governmental regulations (Aldrich, 1976).

Ruscio (1984, p. 179) noted that the interorganization literature provides concepts that assist in describing what occurs in interorganizational relationships as well as allowing for identification of potential problems. Some of the concepts that may be useful in analyzing the linkages under consideration are boundary spanning, resource dependence, organizational set, action sets, network, coordination and coordinating mechanisms. Boundary spanning refers to those activities that occur along boundaries between organizations. Boundary spanners are therefore exchange agents between the organization and the environment, whose role is to filter and interpret information and act as gate keepers and change agents. Thomson (1967) noted that boundary spanners must use influence in protecting their organization's technical core and representing the organization to external groups, in processing resources and in marketing the organization's products and services.

Seymour(1989, p. 11) identified a number of boundary spanning activities described by Miles (1980) that college and university administrators must manage. These are representing, scanning and monitoring, processing information and gate keeping, transacting, and protecting. Representing is the presentation of information about an organization to its environment in order to shape the opinions and behaviours of other organizations, groups, and individuals (p.11). Seymour summarized this boundary spanning activity as "intended to create and manage the image of the institution to its outside constituencies to create impressions that lead to the enhancement of the institution's integrity, power, and autonomy in its environment" (p. 13). Scanning is an organization's search for major discontinuities in its external environment that may present opportunities or constraints (p.13), whereas monitoring "involves tracking environmental indicators that have been established as strategic contingencies [and] involves greater focus and a more detailed examination of changes over time" (pp. 13-14). Seymour (1989) noted further that

monitoring is normally focused on a particular issue (p.15). He, however, cited a number of the constraints faced by colleges and universities in scanning and monitoring as reported by Hearn and Heydinger (1985). Some of these are:

1) The discipline-driven nature of higher education makes it difficult to balance the environment of the "organization whole" with semi-autonomous disciplinary environments.

2) The need for future-gazing is often quashed by the more restrained, rationalist culture of academic institutions.

3). The loose-coupling within most colleges and universities precludes the timely, organization wide environmental responses possible in other organizations.

4) The cultures and histories of higher education institutions can result in most environmental influences being resisted as challenges to the status quo.

5) The dominant governance norm of participatory management conflicts with the demands of turbulent environments (Seymour, 1989, pp. 15-16).

Processing information and gatekeeping involve interpreting, translating and filtering knowledge of the environment. The meaning of environmental information should be "interpreted in terms of opportunities, constraints, and contingencies it poses for the organization" (p.16). Seymour (1989) further noted that "the information-transmittal process therefore seeks to balance the institutions need for both adaptability and stability. Boundary spanning activity must entail the activity of change agents as the institution seeks to align internal resources with external opportunities and threats" (p. 17). Transacting refers to the acquisition of inputs and the disposal of outputs(e.g., research results) in the organization.

Linking and coordinating is an important boundary spanning activity, especially in collaborative arrangements between organizations (p.18). Seymour (1989) cited Whetten's (1981) categories of three groups of coordinating structures, namely: mutual adjustment (the weakest form of coordination), corporate adjustment (the strongest) and alliance (an

intermediate category between the other two). He noted that the majority of university-corporate relations fall in the alliance category (p. 19).

Protection is another important boundary spanning activity. On this Seymour stated:

> As a consequence of growing interdependence, organizations make more attempts to obtain some degree of control over one another's activities. Therefore, boundary spanning should entail a measure of self-defense. While overprotection will cause an organization to loose touch with its external environment, underprotection can create steady dilution of an institution's mission and social system. One of the most distinctive features of higher education is its tradition of autonomy and academic freedom. (p. 20)

Protection will therefore involve balancing the universities' autonomy and academic freedom versus corporate influence, basic and applied research, time and resources devoted to teaching versus university industry research (Seymour, 1989, p. 20). In discussing the critical role of boundary spanning for post-secondary institutions, Seymour claimed, "no longer can campus administrators passively observe the activities that occur on the boundaries of their institutions. They must manage them, just as they manage their budgets or their staffing" (p. 20).

Most of the studies on interorganizational relations have examined the degree of effectiveness of the linkages in terms of such criteria as formalization, intensity, reciprocity and standardization. Formalization refers to the degree to which the interdependence between the organizations is given official sanction by the development of some form of coordinating mechanism. Intensity is the degree of frequency of interactions between the organizations forming the partnerships, and reciprocity refers to the degree of mutuality of the relationship, quite often reflected by the extent to which the resources are mutually exchanged between the participating organizations. Standardization is the development of similarity over time in the procedures used for the transaction.

The Organization of Research in Universities

This section provides a brief background to the organization of research in universities with particularly focus on university-corporate relations.

The Role of Vice-President (Research)

Enros and Farley (1986, p. 15) noted that offices of research administration arose in the last 20 years as a result of an extraordinary increase in sponsored research in Canadian universities. These offices, they added, resulted from organizational changes aimed at fostering and organizing research as well as solving the problems associated with increased research activity and funding. They stated that "accompanying the emergence of offices of research administration has been the formulation of more explicit research policies as evidenced in the creation of vice-presidents or associate vice-presidents for research or in the development of industrial strategies" (p. 15).

Linkage Coordinating Structures (Liaison Offices)

Since the establishment of linkages with industry, universities have established organizational structures to coordinate these linkages. Tietel (1989) noted that there are several structures in universities that facilitate business oriented activities at the university level such as promoting, brokering and sometimes overseeing an end of some research contract with industry (p. 51). Stankiewicz (1986, p. 52) reported that government sponsored liaison offices in universities have been in operation for years in a number of countries such as France, the Federal Republic of Germany, and the United Kingdom, among others. He observed that liaison offices are normally university based and have the responsibility of facilitating the formation of contacts between academic scientists and companies. Some function as little more than simple "information centres" where interested parties can learn about the university's R &D activities. Some play the role of "go-between" assisting to define and administer agreements/projects between industry and

academics and engaging in marketing R&D services offered by the university (pp. 51-52). Stankiewicz (1986) noted, however, that "some academic scientists with well developed contacts with industry see liaison units as superfluous or even objectionable" (p. 52 reference to Allesh, 1982). Tietel (1989) also observed that in contrast to colleges, university liaison offices

> have less autonomy in dealing with companies because at the university level, a greater decision role is retained by the individual faculty members and departments. The expertise for which companies come to the university resides more specifically in the individual faculty members. (p. 51)

Commenting on the European Economic Community, Kirkland (1992, p. 327) noted that there was considerable evidence that internal structures in universities were being amended to accommodate the needs of university-industry collaboration. He further remarked, however, that changing attitudes in some areas may be a more difficult process. Kirkland (1992) observed that

> while universities have established industrial liaison activities to promote and administer external links, there is only limited evidence that measures are being taken to improve project management skills of academic staff and thus ensure that the quality of service provided in individual projects is of commercial standard. (p. 328)

Stankiewicz (1986) outlined the following conditions/features/principles for success of university-industry liaison units that came out of a 1982 Stockholm workshop:

1) Liaison units should be located within the university structure; it is essential that the local officers are intimately familiar with the departments and their activities;

2) It is crucial that the officers are perceived as being competent, particularly by the scientific community; careful recruitment is therefore decisive; mistakes are as a rule hard to correct;

3) In order to assume the right sort of recruitment, it is important that the liaison function has high visibility and status within the university structure;

4) The liaison units should adopt an active marketing approach rather than passive service-on-demand approach;

5) The liaison function should, preferably be linked to other interface mechanisms (such as research institutes, technology transfer units or research parks) rather than operating entirely on their own (p. 53).

Erickson and Baldwin (1989) observed while that there are many variations of the different operating models of university-industry partnerships, "the two basic approaches to handling patents, licensing, and industrial liaison activities in academic institutions are in-house offices and outside-agent models" (p. 29). Noting that there are pros and cons of each of these models, and that the right choice depends on the circumstances of each university, they stated that the in-house model would be more appropriate and responsive to the institutions needs if it is adequately staffed with competent and experienced people. They, however, noted that the investments for this model is quite high such as the acquisition of patent attorneys, market analysts, industrial liaison experts and other support staff. They reported that

> given the large up-front investment and the relatively high risk of that investment many universities opt for an outside-agent model. It ensures immediate availability of the required legal, marketing and business expertise. It avoids the need for substantial up front money to cover evaluation, patenting, and marketing costs, pending much later recovery of those costs through fees and royalties. It also avoids the very real risk that up front expenses will never be fully recovered. What the university gives up in this model is some degree of responsiveness to its particular needs and some share of the income that must be allocated to the agent. (p. 30)

They noted, however, that some universities have tried to have the best of both models by using a combination of the two approaches (p. 30).

Conceptual Framework

In this study, university-industry partnership is conceptualized as a consummation of an agreement to achieve respective goals and objectives. This conceptualization is simplified and illustrated in Figure 1. Both the university and industry intending to form the linkage/partnership have goals, needs and objectives which they anticipate can be better achieved by cooperatively working together in a partnership (motivations/rationale for the

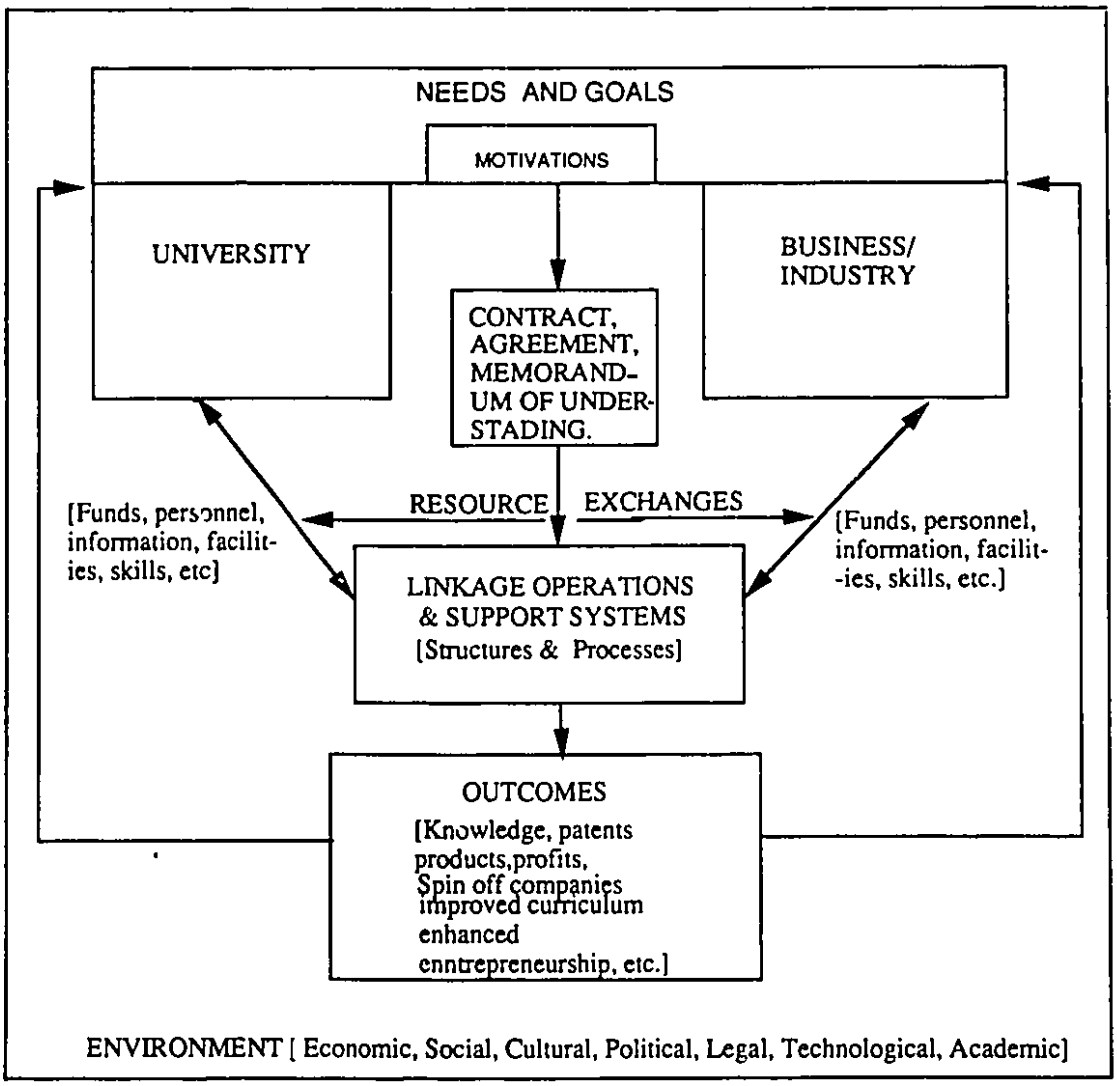


FIGURE 1: A Conceptual Framework of University-Industry Partnerships

establishment of the linkage). However, before the partnership or linkage is formed, negotiations on the details of the agreement, such as what each of the parties has to contribute to the partnership and the benefits that each anticipates to get from the partnership, have to be made. Once all these details are agreed on, the partnership is sealed or consummated by a legal agreement such as a research contract or even through a memorandum of understanding (framework for establishing the linkage).

The partnership has, however, to be put into operation (linkage operations) in order to bear the expected results. This is done through appropriate organizational structures and processes already present or created for the purpose through effective coordination and management of the partnership. The organization, coordination and management of the linkage in the context of the two institutions has to be done (thus the need for appropriate management and related support systems). The linkage operations will also involve, among other things, the exchange of resources such as funds, personnel, information and facilities. The effective and efficient coordination and management of the linkage as well as the presence of appropriate organizational structures, climate and incentives will likely determine the degree of success of the partnership that is expected to lead to anticipated accrued benefits (outcomes of the linkage operations such as knowledge, patentable ideas and patents, innovation, improved curricula, production of superior manpower, establishment of spin off companies, tangible products or production of superior products, greater competitiveness and profits, attitudes, etc.). The linkage is similarly expected to have impact positively or negatively on the attitudes and values not only of the participants in the partnership and those within the two partner institutions but also on those outside these institutions who will be affected in one way or the other by the activities of these partnerships (outcome of linkages). It is important to bear in mind, however, that linkage operations are conducted within given internal and external environments (economic, social, cultural, political, legal, technological and academic) of the two participating institutions in general and of the respective participating departments or research institutes

in particular, where the partnership operations actually take place. The environment has, therefore, some effect on the nature and the efficacy of these linkage operations; thus, the need to pay due attention to the different environmental factors that impact on these linkages.

CHAPTER 3

RESEARCH DESIGN AND METHODOLOGY

This chapter describes the theoretical orientation which served as the basis for the research methodology adopted for the study. The approach utilized for this inquiry was interpretive and qualitative. The chapter further provides a description of the research design, data collection and data analysis procedures utilized, and the measures taken to ensure the trustworthiness of the findings.

Research Design

Merriam (1988) likened a research design to an architectural blueprir and defined it as "a plan for assembling, organizing, and integrating information (data), and it results in a specific end product (research findings)," noting further that the "selection of a particular design is determined by how the problem is shaped, by the questions it raises, and by the end product desired" (p. 6). Merriam observed that in research design a distinction is often made between experimental and nonexperimental research. The main objective of experimental research is to investigate the cause and effect relationship. In this type of research, the researcher can manipulate the variables of interest and has therefore great control over the research situation. The non-experimental research, on the other hand, which is often called descriptive research "is undertaken when description and explanation (rather than prediction based on cause and effect) are sought.... The aim of descriptive research is to examine events and phenomena" (p. 7). Case studies are considered as a form of descriptive non experimental research. Given the exploratory nature and the dimensions of this study, a descriptive and interpretive case study employing qualitative research strategies was adopted for this inquiry. The study was conducted from the perspective of what Burrell and Morgan (1979) called the interpretive paradigm which

"sees the social world as an emergent social process created by individuals concerned" (p. 28).

The Nature of Interpretive Research/Naturalistic Inquiry

A number of writers have discussed the different approaches to discovering truth and doing research. Owens (1982) noted that although there are several approaches in the field of human inquiry for discovering "truth" and for "knowing" and "understanding" phenomena, two have clearly emerged as the major inquiry paradigms in science. These are the rationalistic and naturalistic paradigms. About this, Owens (1982) stated:

> They are different paradigms arising from different perceptions of such things as the nature of social phenomena and ways of understanding them. Although the two paradigms tend to compete for legitimacy and support, they are, in fact, complementary methods of investigation, available for use in the knowledge production process essential to informing educational administration. (p. 3)

The rationalistic paradigm which is the dominant established tradition in systematic inquiry, according to Owens (1982), is "essentially associated with deductive thinking and logical positivist views [about] 'understanding' social and organizational phenomena"(p. 3). The naturalistic paradigm, on the other hand, is based on inductive thinking and phenomenological ways of knowing and understanding. The major differences between the two paradigms are based on the following assumptions:

1) The nature of reality. The rationalistic paradigm is based on the assumption that there is a single, objective reality out there that can be observed, known and measured. Expounding on rationalistic inquiry, Owens (1982) stated "Essentially, the view is that what exists can be extrapolated from its environment, and because it exists , it exists in some measure, and thus can be quantified"(p. 4). The naturalistic paradigm, on the other hand, holds the view that there are multiple realities about the world and "the real world we encounter 'out there' is such a dynamic system that all of the parts are so interrelated that one part inevitably influences the other parts"(Owens, 1982, p.6). This paradigm supports the view that "one cannot understand human behavior without

understanding the framework within which the individuals under study interpret their environment, and that this can best be understood through understanding their thoughts, feelings, values, perceptions and their actions"(p.5).

2) The inquirer/object of inquiry relationship. Whereas the rationalistic paradigm holds that an objective distance between the researcher and the object being investigated should be maintained, the naturalistic paradigm assumes that the inquirer and the respondent or subject under study may become interrelated.

3) Research approach. In rationalistic inquiry, quantitative methods are preferred to non-quantitative methods; the use of *a priori* theory, and hypothetico-deductive methods (hypothesis testing) is important to the design of study and to the cumulation of knowledge (Owens, 1982, p. 4). He summarized the rationalistic approach to research stating, "Operationally, research organized by the tenets of the rationalistic paradigm begins with an existing theory which is used to set up an articulated problem in advance of the inquiry" (p. 4). In naturalistic inquiry, qualitative methods are preferred. "Qualitative methodology allows the researcher to get close to the data, thereby developing the analytical, conceptual, and categorical components of explanation from the data itself" (Owens, 1982, p. 6 quoting Filtead, 1970, p. 6). Owens (1982) went on to state that

> Qualitative inquiry seeks to understand human behavior and human experience from the actor's own frame of reference, not the frame of reference of the investigator. Thus naturalistic inquiry seeks to illuminate social realities, human perceptions, and organizational realities untainted by the intrusion of formal measurement procedures, or reordering the situation to fit the preconceived notions of the investigator. The qualitative nature of the resulting description enables the investigator to see the 'real' world as those under study it. (p. 7)

Bogdan and Biklen (1982) have noted that qualitative research is an "umbrella term" (p. 2) that has been used to describe research strategies with the following salient characteristics :

1) Qualitative research has the natural setting as the direct source of data, and the researcher as the key instrument.

2) Qualitative research is descriptive.

3) Qualitative researchers are concerned with the process rather than simply the outcomes and products and products of their research.

4) Qualitative researchers tend to analyze their data inductively.

5) "Meaning" is of extensive concern in this approach (pp.22-30).

Based on the interpretive paradigm, this study sought to describe and explain the perspectives and experiences of those involved in collaborative research and development activities between the University and industry. Although the study is basically qualitative in nature, some background quantitative data are provided in Chapter 4 to further illuminate the total picture of these activities. Some numerical data are also used in Chapters 5 and 6 on the number of respondents that commented on a particular theme. These numbers must not be seen, however, with a comparative weighting in mind. This is because given the design of the study the respondents were not always asked the same questions. Quantitative data are used only for purposes of clarification and in a few instances, elimination of ambiguity.

Research Strategy: The Case Study Approach

According to Bogdan and Biklen (1982), a case study "is a detailed examination of one setting or one single subject or one single depository of documents or one particular event" (p. 58). Dyer (1979, p. 188) noted that case studies are distinguished by their intensive, detailed investigation of a single unit: an individual, a classroom, a school system, a society, or a community. Merriam (1988) has defined a case study "as an examination of a specific phenomenon such as a program, an event, a person, a process, an institution, or a social group" (p. 9) and further emphasized that the case study approach "aims to uncover the interaction of significant factors characteristic of the phenomenon. The case study seeks holistic description and explanation" (p. 10). Merriam (1988) further outlined the following four essential characteristics of a qualitative case study:

Particularistic: in focusing on a particular situation, event, program or phenomenon . Further Merriam states that "the case itself is important for what it reveals about the phenomenon and for what it might represent. The specificity of focus makes it an essentially good design for practical problems--for questions, situations or puzzling occurrences arising from everyday practice" (p. 11).

Descriptive: A qualitative case study is descriptive because its end product "is a rich, 'thick' description of the phenomenon under study"(p. 11);

Heuristic: Cases "illuminate the reader's understanding of the phenomenon under study..., bring about the discovery of new meaning, extend the reader's experience or confirm what is known" (p. 13)

Inductive: inductive reasoning from the derived data should lead to generalizations, concepts or hypotheses emphasizing that "discovery of new relationships, concepts, and understanding, rather than verification or predetermined hypotheses, characterizes qualitative research" (p. 13). Rist (1982) noted that one of the functions or advantages of case studies is that they allow for identification of other problems and variables that may not have been anticipated at the beginning of the study and they also provide a context for statistical data that may be part of the information included in a description of a social problem; they establish a context for a more in-depth analysis of behavior or other phenomena related to the research undertaken.

In this study, the case study approach allowed an in-depth investigation of the university-industry research and development activities (the motivations, the structures, partnership mechanisms, the processes, problems and challenges faced, lessons learned) by those involved in the selected partnerships at the University of Alberta and the context in which these partnerships take place. The ultimate aim was a holistic integrated description and interpretation (understanding) of these activities.

Data Collection Strategies

Data for the study were gathered mainly through document analysis and use of semi-structured interviews. After reviewing the relevant literature on university-industry collaboration in R & D, the researcher developed a semi-structured interview guide for the study and this continued to be improved as the study proceeded from the pilot stages through to the interviews in the main part of the study

Pilot Study

Before embarking on the main study, a pilot study was conducted with two administrators and two researchers in each of the University and industry sectors. This exercise allowed the researcher to field test the interview guide. The purpose of this pilot stage was to allow the researcher to modify and improve the interview guide as appropriate with regard to the wording of the questions, their clarity and precision and the duration for the interview, thus strengthening the reliability of this data collection strategy. As a result, a few questions were modified and where there was repetition or where different questions elicited the same responses, some of these were eliminated.

Phases of the Study

The study was conducted in two phases:

Phase 1. This involved searching for relevant documents and extracting relevant data as well as interviewing the selected researchers and administrators in both the University and industry sectors. The main aim of this phase was to get the general picture, the pattern and the nature of collaborative research and development (R & D) partnership activities at the University of Alberta. This involved finding out the types of relationships with the corporate sector that existed in R & D, the structures and processes that have been put in place for these partnerships, the benefits, the problems and challenges that they face, among others. This phase also included the search for the characteristics of the organizations that have collaborative R & D relationships with the University.

Phase 2. This consisted of detailed examination and analyses of two selected partnerships in R & D between the University and industry (their initiation, motivations, management, organization, coordination, benefits, problems and challenges). The two that were selected were:

(a) one affiliation research agreement between the University and a local firm;

(b) one consortium in which the University was both a member and one of the co-founders.

Selection of Partnerships and Interviewees

Some background information on research partnerships that the university had with industry was sought and obtained from the Intellectual Property and Contracts Office (IPCO). Information on industrial awards for research grants and contracts from 1980/81 to 1993/94 was provided by IPCO. These yearly lists contained the names of the researchers in different faculties and departments, the amount of industry grants and contracts awarded to them, and the names of the industries providing the sponsorship, whether they were Canadian or foreign. From the 1993/94 list, the researchers were selected and interviews were requested. An effort was made to have at least two researchers from each faculties in the list and their selection was based on the duration of their involvement in these partnerships. Thus if certain names were listed over the years in the lists these were selected. The reason for this strategy was that their wealth of experience over the years would be enriching. Some researchers had more than one research grant and contract from different firms and this too influenced their selection. Some of these research partnerships had already become known to this researcher as their collaborative activities had been publicized in the University and local media. Similarly, from the same list industries to be included in the study were chosen and interviews with officials of these companies were requested. Since research partnerships as outlined in the 1993/94 list were mainly confined to the faculties of Engineering, Medicine, Pharmacy and

Pharmaceutical Sciences, and Science, most of the researchers interviewed were from these faculties.

Eleven companies participated in the study, eight in the Edmonton area, one in Fort McMurray but with a branch in Edmonton, and two in Calgary. This includes the two that were selected for detailed study. Rather than concentrate on the companies based in Edmonton, it was decided that getting different perspectives from those in other towns might be illuminating as well. In total, 40 respondents participated in both phases of the study; 20 respondents from industry (12 for phase 1 and 8 for phase 2).were interviewed and 22 respondents from the University (20 participated in phase 1 and five of the 22 participated in phase 2.). Some respondents participated in both phases of the study as will be explained later. A summary of characteristics of phase 1 respondents is provided in Table 1.

Table 1: Summary Characteristics Phase1 Respondents.

	University	Industry	Total
Primarily an administrator	8	5	13
Primarily a researcher	14	-	14
Administrator/ Researcher	-	7	7
Total	22	12	34

Selection of Specific Research Partnerships for Detailed Case Studies.

Although most of the R &D collaborative partnerships were made through industrial grants and contracts, which in most cases involved individual researchers doing research

for industry, there were a few other types of collaboration which involved more than research grants and contracts. Two of these were chosen for detailed study and these were:

1) The Research affiliation agreement between the University and an Edmonton-based company. This partnership was selected because it was the first agreement of its kind between the University and a company. It was anticipated that the experiences of those involved in the collaborative research activites betwen these two institutions would be insightful. The president of the company, one other senior administrator and two researchers in the company were interviewed and follow-up interviews were carried out later. One university central administrator and one faculty administrator participated in the study as well.

2) A consortium in which the University was a member and one of the co-founders. This consortium, a joint venture, was selected because it offered a unique feature of university-industry collaboration involving not only the University of Alberta but other universities and industries. Further, this partnership provided for an element of graduate training on a larger scale than is to be found in the other partnerships. Once the consortium was selected, the president and one other senior administrator from the consortium were interviewed. In addition, two senior administrators from participating companies, one from a small company and the other from a large company were interviewed for their experiences and perspectives in the consortium. Similarly, two university researchers involved in the program and one administrator participated in the study. The information about the respondents that participated in Phase 2 part of the study is summarized in Table 2.

Table 2 : Summary Characteristics of Phase 2 Respondents

	University	Industry	Total
Primarily an administrator	2	6	8
Primarily a researcher	3	2	5
Total	5	8	13

It should be pointed out, however, that although the total respondents for the two phases add to 47 this is less than the actual respondents interviewed. This because five respondents participated in both phases of the study.

Data Collection Methods

In this section the methods used to collect information for the study are presented. First, the use of interviews is presented, followed by the utilization of relevant documents.

Interviews

Semi-structured interview guides were used because these allowed for more in-depth inquiry or probing where necessary. According to Borg (1987), in semi-structured interviews "the interview follows a guide that lists questions covering all essential information needed by the researcher. However, (the researcher) has also the option to follow up any answers in an effort to get more information or clarify the respondent's replies" (p. 112). Interviews were conducted by the researcher with the following University administrators: The Vice-President (Research), a former Vice-President (Research), five Associate Deans (Research) in the faculties, the Director of the Intellectual Property and Contracts Office (both the incoming and the outgoing), three other

administrators at the Intellectual Property and Contracts Office, and Nine other University researchers who were also involved in university-industry research. It should be pointed out, however, that four of the associate deans were currently or had been involved in university-industry research and thus provided their perspectives as researchers as well. In fact most of the time the associate deans spoke as researchers rather than as administrators, often making reference to central administration *vis a vis* faculty administration. The administrators and researchers in the selected research partnerships for the detailed case studies were also interviewed. All the interviews were tape recorded. Each interview lasted for about 40 and 60 minutes. The researcher also took notes of key points during the interviews. The interview guides for the study are attached as Appendices 1 and 2.

Data from Documents

Relevant documents relating to university-corporate linkages were obtained and analyzed to extract relevant data. The following documents were examined: federal and provincial government reports such as commissions, policy documents, university and industry policy documents on research partnerships, partnership agreements of selected partnerships; and minutes of meetings of the General Faculties Council, the Senate and the Board of Governors pertaining to partnerships. Relevant correspondence and other research reports were also examined. Relevant documents from the faculties and departments involved in research partnerships, as well as those from the selected research partnerships for detailed case study were studied and utilized. The selection of these documents was based on the researcher's judgment as to their utility in achieving the purposes of this study.

Data Analysis

After the relevant information had been collected from the documents and in the interviews, the data were then analyzed. Merriam (1988) stated that data analysis "is the

process of making sense out of one's data" (p. 127). Bogden and Biklen (1982) defined and described the procedures of data analysis in qualitative research in this way:

> Data analysis is the process of systematically searching and arranging the interview scripts, field notes, and other materials that you accumulate to increase your own understanding of them and to enable you to present what you have discovered to others. Analysis involves working with data, organizing it, breaking it into manageable units, synthesizing it, searching for patterns, discovering what is important and what is to be learned, and deciding what you will tell others. (p. 145)

These procedures were utilized both at the interview phase and in subsequent phases. The interview responses were transcribed and major themes identified. Content analysis was carried out on the data obtained from the interviews and relevant documents. The data were analyzed and interpreted accordingly in response to the research questions and in the light of the relevant literature on university-industry partnerships.

Research Trustworthiness

In positivistic research, the determination of validity, reliability and objectivity are critical in ensuring accuracy of the findings and conclusions of the study. In qualitative research, the term "trustworthiness" is used to address the issues posed by validity and reliability. According to Guba and Lincoln (1982) validity or "trustworthiness" of qualitative research is concerned with truth, value, applicability, consistency and neutrality. Lincoln and Guba (1985, pp. 289-331) recommended, therefore, that in order to ensure the trustworthiness of the data collected, the researcher should ensure that the findings are credible, dependable, confirmable and transferable.

Credibility is the extent to which findings and interpretations are seen as credible by the participants (p. 296). Lincoln and Guba (1985) recommended that care must be taken in gathering and recording data, and that continual scrutiny is necessary to eliminate distortions and enable the researcher to produce a truthful and credible report. .This is important in view of the fact that in qualitative research , the major concern is whether the researcher's analyses and interpretations reflect the views and perception of the

respondents. Dependability refers to the verification for consistency of findings of one researcher by another. Confirmability refers to the extent to which the data used in the study can be confirmed from other sources (Lincoln and Guba, 1985, p. 300). Triangulation, which is the use of multiple sources of data, was used to ensure credibility and confirmability. In this regard data from interviews were analyzed vis a vis relevant documents and other literature. The researcher strove to ensure that credibility checks occurred throughout the study both at the data collection and data analysis phases e.g. having the interviewees check the researcher's summaries of their interviews to ensure that all their perceptions had been correctly recorded. Verifications and review of data and researcher's interpretation of these data by a research colleague helped to enhance the trustworthiness of the data.

Ethical Considerations

This study was conducted in accordance with the University of Alberta 1991 Research Ethical Guidelines for the protection of human research participants. Before undertaking this study, approval to conduct the research was sought and obtained from the Ethics Committee of the Department of Educational Administration. Permission to undertake the study was sought in writing from appropriate authorities in the University and industries that participated in the study. Permission to interview the participants was sought through telephone contacts and in writing. Letters of introduction of the researcher to these authorities and respective respondents were written by the researcher's supervisor, explaining the purpose and the nature of the study. A sample is attached as Appendix 3. The researcher followed up the process through telephone contacts. In making this request the researcher detailed the purpose and the process of the study to prospective interviewees and explained their rights as participants in the study. The participants were requested to indicate their consent by signing a consent form which detailed their rights as interviewees. This form explained their right to withdraw from the study at any point

should they wish to do so, and gave assurance of their anonymity and the confidentiality of their responses except where agreed upon. The interview consent form is attached as Appendix 4. Once the interviews were transcribed these were returned to respective respondents for confirmation and to ensure that inaccuracies, omissions, and errors were identified and corrected.

CHAPTER 4

UNIVERSITY-INDUSTRY PARTNERSHIPS AT THE UNIVERSITY OF ALBERTA: CONTEXT, ORGANIZATION AND MANAGEMENT

Introduction

This chapter provides background information on the University of Alberta's partnership activities with the private sector. First, a brief historical note on the evolvement of the University's partnerships with industry is provided. This is foliowed by an examination of the external and institutional policy framework under which these partnerships operate. The organization and management of these activities is then discussed and, finally, a description of the current partnerships, and their funding is given.

Contextual Background and Developments

University of Alberta Context: A Brief Historical Note

The University of Alberta is one of the earliest universities to establish links with industry in Canada. As far back as 1937, the University was already involved with research for industry. However, it was not until the early 1980s that the University began to focus more on the development of collaborative links with industry, and with the establishment of appropriate structures to foster these collaborations.

Office of the Vice-president (Research) and Office of Research Services. In July, 1981, the University of Alberta established the Office of the Vice-President (Research). One of its functions was "to improve support for the research efforts of faculty and to promote the transfer of discoveries and innovations to industry and the community" (Enros and Farley, 1986 p. 38). This move was extended a year later when the University reorganized the Research Grants and Contracts Office and set up the Office of Research Services (ORS) in October 1982 to revitalize the University's research efforts. In 1983, a director of the Office of Research Services was appointed from industry and his

chief mandate was "to develop closer links between the private sector and the University" (1982/83 B.O.G. Report, p. 9). The function of the Office of Research Services was

> to be active in marketing the University's research capacity and formulating technology transfer arrangements between the university and industry. The Office of Research Services encourages transfer of University research into the public and industrial sectors by developing relationships among potential transfer participants, introducing researchers to government or industry representatives and facilitating transfer mechanisms. (Manual of Administration Policies, Procedures and Services-Mapps-1986 Appendix 7)

In the early 1980s the University continued to develop interest in, deliberate on and initiate activities to enhance technology transfer activities from the University to the industrial sector. For instance, this theme of collaboration with the private sector continued to be discussed in subsequent Board of Governors meetings. Issues on patent policies, and procedures for collaboration between the two sectors continued to be discussed and worked out in these meetings. In a report to the Board of Governors meeting in December 1982, the Vice-President (Research) stated that

> even were income from research royalties to be non trivial, our major interest in pursuing research leading to patents must be and must be seen to be, encouragement of technology transfer and the establishment and encouragement of industry and agriculture in Alberta and Canada. (p. 143)

The Vice-President noted further that

> the growing network of university-industry contracts poses a challenge for which we must be ready. The flow across this boundary has been largely from university to industry; I believe we shall profit from a two-way exchange in which industrial scientists and engineers will have an important place on the campus in both research and teaching. (p. 144)

In 1983, the Vice-President (Research) established an ad hoc committee on private companies and research consulting with the University. This committee also addressed the issue of transfer of knowledge and contracts with external agencies. The 1984/85 Board of Governors Report dwelt extensively on the University's role in technology transfer, noting that many new products such as lasers continued to emerge from and remain limited to university research programs (p. 9). The report stated that the transfer of these technologies was made possible though patents, licenses, contract arrangements, joint

ventures, university enterprises and a range of industry-university interactions. The Board pointed out further that

> where often in the past universities and companies have operated in total isolation from one another, the development of new technology in universities coupled with the need in industry for new products, new technology, and information management, creates an environment where liaison is natural; a variety of forms of cooperation is emerging due to the mutual interest of both groups. (p. 9)

The report continued to underscore the University's position in this area stating that "The University of Alberta can and does play a major part in this new wave of technology transfer and does so without compromising its commitment to fundamental research in all fields of scholarship within its precincts" (p. 9).

Establishment of technology transfer position. In 1985, the first formal technology transfer position was created within the Office of Research Services and "since then the University of Alberta has developed a significant technology transfer program that has made real contributions to the Alberta economy" (Enros and Farley, 1986, p. 38). The University's commitment and philosophy on collaboration with the private sector is restated again in the 1988 Research Policies handbook where it was noted that

> Changing conditions in the university environment in the present decade have increased interactions between the academics and the private sector. As a result, the University has placed a major emphasis on knowledge transfer and patents. The University of Alberta patent policy encourages staff members to patent discoveries and inventions. It also provides mechanisms for commercial application and utilization of inventions. (p. 4)

In 1989 a new policy to recover overhead and indirect costs of sponsored research was introduced. In the same year, the Finance Committee of the Board of Governors reiterated its commitment to continually "work closely with administration in setting policies and procedures to encourage and facilitate university based research for potential commercial application or public utilization or that could be developed further through technology transfer agreements" (1989/90 Board of Governors Report, p. 15).

Establishment of the Intellectual Property and Contracts Office. In 1990 the University created the Intellectual Property and Contracts Office in order to enhance further its partnership activities with the private sector. According to The Intellectual Property and Contracts Office Mission Statement (1993), this office

> is responsible for the university's intellectual property transfer process as well as facilitating contract research . It works with the researchers within the University, and with industry and government, as well as other universities and research institutions in carrying out this work. (p. 1)

Establishment of a 1992 task force on national research reports. The University's commitment and interest in research is further evidenced by the establishment in 1992 of a task force comprised of mainly faculty members to examine two Canadian national reports. In consultation with the University Research Policy Committee, the Vice-President (Academic) and the Vice-President (Research) appointed a task force to examine recommendations of two 1991 reports: *Realizing the Potential: A Strategy for University Research in Canada* produced by the Royal Society of Canada (hereafter referred to as The Royal Society Report) and The Association of Universities and Colleges of Canada's *Commission of Inquiry on Canadian University Education* (hereafter referred to as the AUCC Report).

In reviewing these two reports, the task force surveyed the views of the University of Alberta community on these two reports and came out with its report in June, 1993, pointing out the positive and negative elements in the two reports, where it agreed and didn't agree with the reports. The task force criticized the AUCC Report for "its belittling the economic value of discoveries that can result from university research" (p. iii). It supported the Royal Society's call for more support of basic research in the universities and emphasized "that the universities need to support arrangements that foster the transfer of relevant products of their research to the commercial sector" (p. C-2) and added further that "the concept of the Networks of Centres of Excellence, which fosters ties between basic research institutions and the corporate partners deserves further encouragement" (p. C-2).

Citing the establishment of the Wisconsin Alumni Research Foundation (WARF) in 1925 as a landmark in university-industry collaboration and a success story, whereby the university assigned "inventions and processes to WARF, thus distancing the university from direct commercial involvement", the task force observed that despite such cases from history, "it has taken more than a half a century for most campuses in North America to accept even an arms-length involvement in technology transfer" (p. c-19). The task force also supported the Royal Society's Report recommendation for further studies on university-industry collaboration (p. C-18).

Change of name from IPCO to Industry Liaison Office (ILO). In January, 1995, the University Board of Governors approved the change of name of the Intellectual Property and Contracts Office to Industry Liaison Office to reflect more emphasis and focus by the office on university-industry collaboration. Providing the reasons for the change of name, the Vice-President (Research) stated:

> The primary role of the office is to develop collaborative university/industry research programs which promote excellence in research and development present at the University of Alberta. The m[illegible] of the office is not just intellectual property and contracts, but it [illegible]oader, and includes university research development in the l[illegible]se. (Letter from V.P -Research to the Board Finance Commit[illegible] November, 1994)

In the same note, the Vice president also noted that the name IPCO was not well-received by the industrial community and made requests for a more suitable name.

Policy Framework

A number of federal and provincial government policies have played a significant role in fostering university-industry interactions. Although education in Canada is a provincial responsibility, the federal government has played a major role in the field of research especially in post-secondary institutions. The programs summarized below have helped to enhance collaboration between the universities and industry in areas of research and development (R & D).

Federal Government Policies and Programs

In the areas pertaining to university-industry research, there are a number of federal government programs that have been specifically designed to facilitate collaboration between the two sectors. These are the National Research Council (NRC)-Industrial Assistance Program and the federal granting councils' programs .

National Research Council's Industrial Assistance Program (IRAP). This program initiated in 1947 was designed to help small and medium size companies find and acquire technologies that would help them solve their technology problems. The program has continued to date. It provides technical assistance, information and financial support to these companies. The basic aim of the program is the transfer of technology from research institutions to companies and assist in the development and adoption of these technologies. The ultimate objective is to assist these companies to be competitive in the domestic and international markets (Supply and Services Canada, 1991, pp. 1-2). The National Research Council (NRC) has Industrial Technology Assistants located at some Canadian universities and essentially work on IRAP related business with companies.

Strategic grants program of the federal granting councils. The federal government funds university research mainly through three granting councils. These are: the Natural Sciences and Engineering Research Council (NSERC), The Medical Research Council (MRC), and the Social Sciences and Humanities Research Council (SSHRC). These councils fund different categories of research projects. The ones specifically geared to university-industry research are described in brief as follows:

Natural Sciences and Engineering Research Council university-industry programs. The Natural Sciences and Engineering Research Council (NSERC) of Canada is Canada's largest research granting agency which provides over 4000 hundred million dollars annually to university research and for the training of

scientists and engineers. This agency promotes collaboration between universities, Canadian companies and research oriented federal government departments.

A 1991 NSERC Program guide, *Research Partnerships: University-Industry Cooperative R & D Activities*, stated that the mandate of NSERC's University-Industry Programs is to

> provide opportunities to exploit the special knowledge and expertise at Canadian universities for the benefit of the Canadian economy.... Cooperative R&D activities supported can be any type, including: basic or applied research in the sponsoring company's field of interest; R&D projects of significance to their sponsors; progress towards commercializing discoveries from academic research programs; and help with the cost of acquiring equipment or facilities that will be shared between a university and a company or used in collaborative research projects relevant to industry. (p. 2)

NSERC funds the following three types of cooperative research and development (R & D) university-industry programs in Canadian universities:

1) Collaborative Research and Development (CRD) Grants;

2) Industrially Oriented Research (IOR) Grants; and

3) Shared Equipment and Facilities (ESF) Grants.

The *Collaborative Research and Development (CRD) Grants* are provided to support projects "that are carried out jointly by the university and the company" (NSERC Research Partnerships, 1991 p. 4). Both the university researcher and the collaborating company are expected to provide periodic reports to NSERC on the progress of the research. A formal agreement is normally signed that spells out the details of the project and the disposition of the intellectual property. One of the requirements of this program is that the company has to make a cash contribution to the project which may also include in kind contributions such as services or equipment. NSERC funding will be based on the company's contribution.

The *Industrially Oriented Research (IOR) Grants* support less focused projects than collaborative research and development grants such as when an industrial partner or a company wants to "enhance the research and learning environment of the university;

support generic research and train research personnel in its area of interest or lay the foundation for a closer interaction with a university researcher" (p. 6). The company is expected to contribute half of the costs of the project and NSERC will usually match the company's cash contribution.

The *Shared Equipment and Facilities (SEF) Grants* help a university acquire specialized equipment or facilities that the university will share with the industrial partner The program's goal is to assist the university and the company to do industrially relevant research alone or together. The company's contribution is usually cash towards the cost of the equipment and NSERC will usually match the amount of the industrial cash contribution (p. 7).

The Medical Research Council of Canada university-industry programs. The Medical Research Council of Canada (MRC) is a federal granting agency responsible for the support of research in health sciences conducted primarily in universities and their affiliated institutes. In Spring 1986, MRC added another objective, namely: "to enhance the interaction between university and industry researchers in the health sciences" (January 1988, the MRC Newsletter, p. 1). Currently, MRC offers the following programs to boost collaboration between the universities and industry:) (a) operating grants, (b) clinical trials, (c) research chairs, (d) industrial fellowships, (e) industrial studentships, (f) workshops, and (g) university-industry jointly sponsored programs.

Provincial Programs

Although most funds for university research come from the federal government, provincial governments also provide funding for research. In Alberta two following two programs deserve mention.

The matching grants program. The Alberta government initiated a program in April, 1989 which matched funds on a one to one basis given by industry and foundations

(private and public) to the universities and other post-secondary institutions in the province for different programs, including research. The purpose was to encourage the private sector to support these institutions. However, this program was discontinued in April, 1991 due to lack of funds.

Alberta Heritage Foundation for Medical Research technology commercialization program. The Alberta Heritage Foundation for Medical Research (AHFMR) was established by the Government of Alberta in 1979 to enhance research and development in the medical and pharmaceutical fields. Currently, AHFMR's technology commercialization program has three phases:

1) AHFMR technology commercialization program phase 1

2) AHFMR technology commercialization program phase 2:

3) AHFMR technology commercialization program phase 3:

The main objective of *AHFMR technology commercialization program phase 1* is "to assist Alberta-based companies, institutions and individuals in advancing health care projects with a wide market appeal to potential commercialization. Projects must be directly relevant to the health care field, show evidence of commercial potential, and be based on original and unique intellectual property" (p. 2). The maximum amount given for this program is $ 25,000 for a maximum of 12 months and no repayment is required.

The *AHFMR technology commercialization program phase 2* has the same objectives as phase one. However, the funds provided to a maximum of $ 75,000 for 18 months is meant to extend the work of the results in phase 1 in the development of the product for commercialization purposes.

Phase 3 of the AHFMR technology commercialization program has the same objectives as the preceding two phases except for the additional emphasis that the project may also "have a unique feature that will ensure successful commercial development in Alberta" (p. 4). The maximum grant for this phase is $500,000 for 24 months and the modalities for repayment are negotiable.

University Policies

As was noted earlier, over the years the University has developed policies to govern its interactions with the private sector. An examination of the General Faculties Council's and the Board of Governor's minutes revealed that this is an area that has received considerable attention in their agendas since the beginning of the 1980s. In March, 1986, for instance, a report entitled, *University Participation in Joint Ventures with Industry, Royalties, Consulting by University staff, and Conflict of Interest* , was approved by the General Faculties Council (GFC) as part of the policies governing university-industry collaboration. Since then the University has continued to modify and improve its policies in this area. As was noted earlier, the Board Finance Committee pledged to work closely with the University administration to develop appropriate policies governing these relationships.

The current policies governing these research collaborations with industry are contained in the latest edition of the Manual on the University of Alberta Research Policies and Services (January, 1994). This manual sets out all the regulations and guidelines that provide the framework of operation for engaging in university-industry research as summarized below.

Research mission statement. The University's commitment to research might be summarized in the following statement in the 1994 Research Policies and Services Manual:

> The central role of the University of Alberta is to undertake, nurture, and promote the growth of quality programs and projects to further the creation, discovery and dissemination of knowledge .... As a dynamic and open institution, the University of Alberta must keep pace with changing research needs and with new research directions. The policy of the University is to develop further its own research capability and to play an increasingly significant part in the development of Alberta as a national and international research and scholarship centre. Such a strategy will lead to the flourishing of the intellectual, industrial, and cultural dimensions of our society. (p. 2-1-1)

Basic and applied research. The policy states that research both basic and applied, is the strength of the University of Alberta and that an essential balance must exist between the two as both depend on each other and that the University rewards and encourages both (p. 2-1-2).

Policies on University-community relations in research. On this area, the policy emphasizes that while relationships between the University and the community (in particular, government and the private sector) are to be encouraged, they must be complementary to, and an extension of, the faculty member's primary scholarly activities. Such relationships the policy states, may result in research grants, and other contractual agreements with the University as well as supplementary professional activity of faculty in the form of consulting services, contract research, product development, employment in any capacity or the private practice of the staff member's profession (p. 5-3-1). Some of the specific policies are discussed below.

1) *Freedom of information and publication rights.* The University of Alberta prohibits classified research. The maximum delay in publication of research results must not exceed 18 months. Individual faculties may, however, insist on shorter delays (p. 5-3-1). Special provisions may, however, be obtained by following the laid down channels (p. 7-3-1).

2) *Conflict of interest.* It is the responsibility of the faculty member to avoid ethical, legal, financial, or other conflict of interest that may adversely affect or conflict with a faculty member's responsibilities to the University or the interests and mission of the University (p. 5-3-2).

Intellectual property policies. The policy document also provides a number of guidelines governing the ownership of intellectual property arising out the university researcher's work . These are:

1) The Patent policy.

2) Research publication policy.

3) Royalty revenue policy.

The objective of the *University Patent Policy* is "to encourage inventors to patent inventions and to promote a mechanism for the commercial application and utilization of inventions while rewarding the inventor and protecting the rights of the University (p. 7-1-1). Invention in the document is defined as "an invention or discovery with patent possibilities made by an inventor in the course of the inventor's duties at the University or through the use of University facilities or resources and includes any computer programs (software) forming part of, and capable of being patented as part of the invention or discovery" (p. 7-1-1). This policy shall apply to all inventions, including those made with research grants, sponsorships, contracts or agreements approved by the University. The inventor has the choice to apply for a patent for his discovery individually, independent of the University, or do so through the University.

On *Research publication policy*, the University research policies handbook notes that the main purposes of University research is "the discovery and dissemination of new knowledge." The policy emphasizes that "University research which is pursued under conditions which restrict publication either in terms of content or beyond limits established from time to time by the General Faculties Council is not compatible with the University policy" (p. 7-4-1).

The policy states further that

> for research grants and contracts funded by external agencies publication of research results not be delayed beyond 18 months from the date of submission of a final report. The University expects that research results will normally be published without any time restrictions. However, the University accepts delays which may be requested or required by the federal or provincial governments or by private industry as set out as follows:
> federal government: normally three months
> Provincial government: normally twelve months
> Private company/industry: normally 18 months. (p. 7-4-1)

Withholding of student thesis: The policy on this matter, states that "in principle, graduate students should not undertake, nor supervisors involve students, in

research for a thesis when the thesis project is part of a contract which prohibits public access to the thesis" (p. 7-4-2). Provisions are made, however, for the approval of a request to withhold publication of a thesis to allow time for patent claims to be made.

The *Royalty revenue policy states* that "due to increased activity in the commercialization of intellectual property, the University is beginning to obtain income from royalties and licensing fees" (p. 7-6-1). The policy on distribution of the University portion of the license moneys is as follows:

> two-thirds to the Vice-President (Research) to offset the costs of the Intellectual Property and Contracts Office which are associated with commercialization of the intellectual property; and one-third divided among the inventor's Faculty, Department, and Laboratory, as determined by the Dean of the Faculty. (p. 7-6-1)

It should be pointed out, however, that when the GFC approved the policies governing interactions with the private sector it also delegated some aspects of this to the faculties. According to the 1988 Research policies Handbook, "each faculty shall establish guidelines and regulations which define boundaries of acceptable relationships as well as procedures for monitoring relationships with the private sector. These guidelines have to be compatible with the University policies on this area." (p. 22).

Research Support Structures

This section describes the organizational structures that facilitate University research activities, and the actual research structures that have been established to carry out research functions, especially those geared towards university-industry research links. First, the organizational structures are given, followed by a description of the research organizations.

Organizational Structures for University-Industry Partnerships

Structures here refers to the administrative and organizational arrangements which the University has put in place for the coordination and management of these research links with the private sector.

Office of the Vice-President (Research). The Vice-President (Research) has the overall responsibility for the administration and direction of the University's research activities. As stated in the 1994 University of Alberta research policies and services manual, "The Vice-President (Research) and the Associate Vice-President (Research) coordinate policy development with the assistance of appointed faculty members serving part time as Research Coordinators" (1994 Research Policies and Services Manual, p. 3-1-1). The organizational chart of the Office of the Vice-President (Research) is provided in figure 2 to indicate how this office is structured. As shown in figure 2, there are two main divisions in the Office of the Vice-President (Research), the Research Grants Office (RGO) and the Intellectual Property and Contracts Office. The main function of RGO is to "facilitate efficient grant application and award procedures for both external and internal research grant funds and to enhance access to information and expertise on research sources and proposal development" (p. 3-5-1). However, the Office that deals mainly with university-industry research links is IPCO.

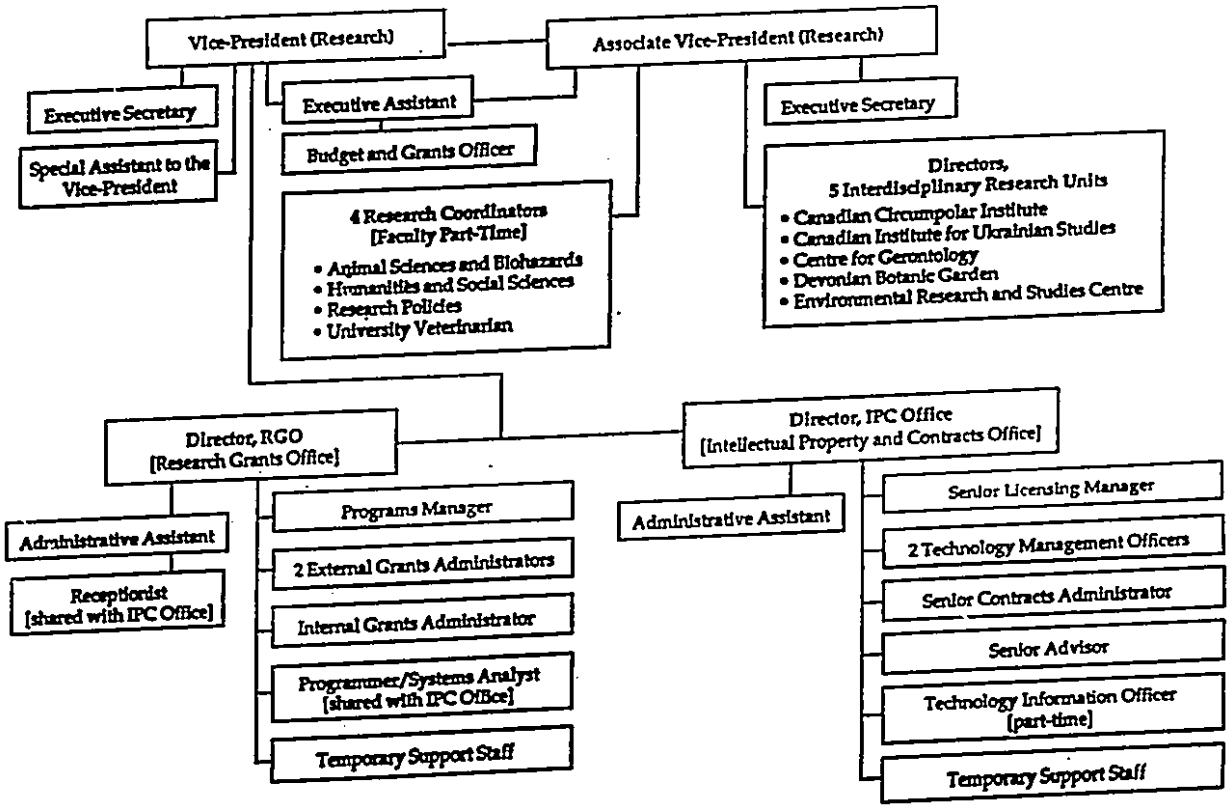
Intellectual Property and Contracts Office [IPCO]. As was noted earlier, this office was established in 1990. IPCO is responsible for the University's intellectual property transfer process and facilitating contract research. It acts as a liaison with University researchers, industry, government , other universities and research institutions in technology transfer programs (Mission Statement, May, 1991).

The 1994 Research Policies and Services Manual outlines the functions of this office (pp. 3-4-1 - 3-4-2). The Office

1) works with organizations and University researchers to facilitate both the protection and transfer of intellectual property;
2) encourages researchers to consider commercial potential of their work and requires that they disclose their discoveries to the University through a Report of Invention Form;

Figure 2

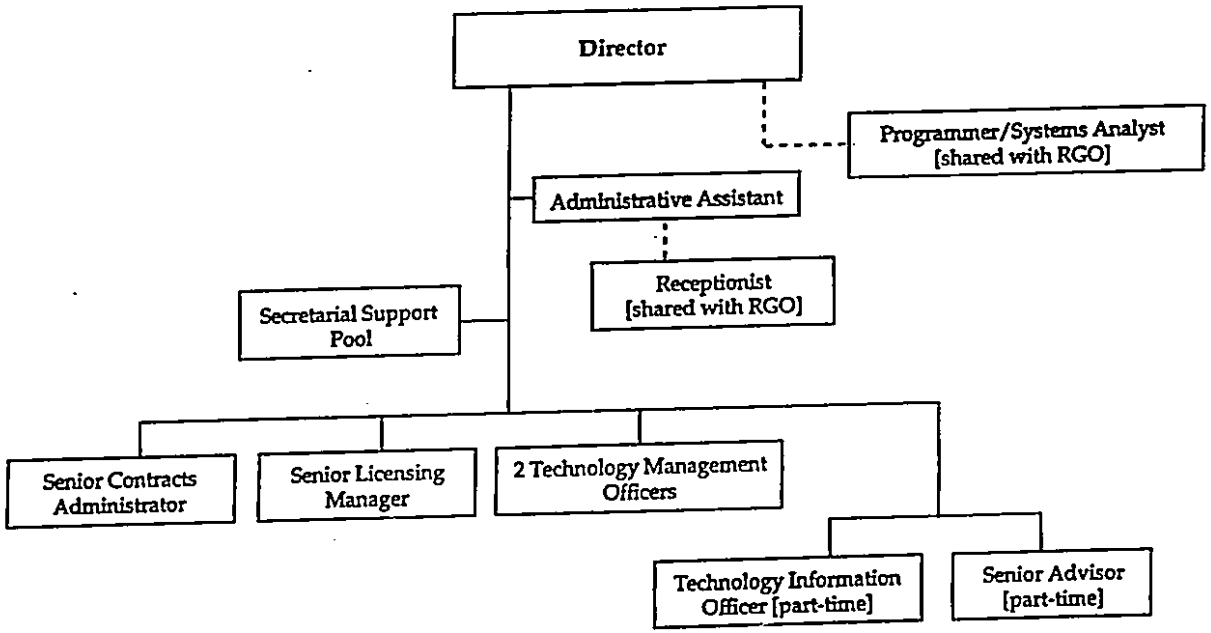
Overall Structure of the Office of the Vice-President (Research)



Source: Office of the Vice-President (Research).

Figure 3

Intellectual Property and Contracts Office
Organizational Chart



Source: Office of the Vice-President (Research).

3) assists the researchers at the initial stage of their inventions by reviewing with the inventor the invention and its proposed applications and commercialization; providing information on patents, copyrights (including computer software programs), and the University's research policies and trademarks; and playing a key role in industry liaison and negotiation.
4) assist University researchers by providing advice on appropriate royalties and terms of agreement and preparing license agreements;
5) help identify University researchers with expertise needed by other organizations (industry included);
6) prepare contracts, provide access to legal counsel and advice on publication rights to University researchers and negotiate for them on behalf of the University;
7) promote and market University technologies;
8) act as liaison between the University researchers and other educational institutions, institutes, centres, and industry in order to foster University-industry collaboration.

The Director of IPCO reports directly to the Vice-President(Research) as shown in Figure 2. The organizational chart of IPCO is provided in Figure 3. . an be seen in the chart, the director is supported by about 11 members of staff. The senior contracts administrator, the senior licensing manager, and the technology management officers are the key officers regarding university-industry partnership activities.

Offices of Associate Deans (Research). Most of the faculties have an Office of Associate Dean (Research) to coordinate all the research activities in the faculty which includes university-industry research. Even in some of the faculties that may not use the designation of Associate Dean (Research), they nevertheless have an office of associate dean that performs similar functions.

University-industry committees. Some of the faculties in the natural sciences, engineering and medical fields have committees that deal with issues of university-industry collaboration. At the time of this study for instance, the Faculty of Medicine had a university-industry working group which was an ad hoc committee that had been established by the dean of the faculty. The Faculty of Engineering had a planning committee which deals with this matter. The Faculty of Science had a University-industry visiting committee. These committees comprised of faculty members and representatives from industry. An examination of some of the minutes of these committees indicated that they deliberated on issues meant to strengthen the collaborative relationship between their faculties and industry.

University Research Policy Committee (URPC). The University of Alberta Research Policies and Services Manual states that "The purpose of the University Research Policy Committee is to develop research policy recommendations for the Vice-President (Research) through the proactive involvement of representative academic members of the University" (p. 11-2-22). Some of the members comprise Associate Deans of Research in the faculties or where these are not in place, deans or their designates, members of the research community, student representatives and the directors of Research Grants Office and the Intellectual Property and Contracts Office. This a standing committee that reports to and is chaired by the Vice-President (Research).

Research Structures

In this section the different research units that form part of the University's research milieu are described. These include research centres, institutes as well as research groups, the federal networks of centres of excellence (NCE), spin off companies, and research consortia.

Research centres, institutes and research groups. Research centres, institutes and research groups constitute part of the University of Alberta's research

landscape. The University of Alberta has over the years established a number of Research Centres, Institutes and Research Groups within and without the academy to enhance the University's research activities including technology transfer to the private sector.

In an introductory note to the 1989 "Directory of Institutes, Centres and Groups", the Vice-President (Research) noted that these three categories "represent a spectrum of interests throughout the University" (p. i) and that they were

> engaged in knowledge transfer in the broad sense, conducting research, offering courses, preparing publications, and performing various services. Their multidisciplinary nature frequently crosses the boundaries of traditional academic disciplines. Many of them forge links with the government and industry, as technology transfer becomes an important element within the university. (p. i)

These research structures are classified under the following three different categories:

1) *Integral unit of the University of Alberta, unincorporated.* Such units are either administered by Chairs of Departments, the Dean's office or the Office of the Vice-President(Research).
2) *Affiliated to the University of Alberta, incorporated, but not for profit.* These are autonomous units that have boards of directors and appoint their own officers.
3) *Affiliated to the University of Alberta, Incorporated, for profit.*

An examination of centres and institutes to date reveals that these have increased in numbers over the years as indicated in the Table 3. It be noted that most of the

Table 3

Establishment of Centres and Institutes at the University of Alberta

Period	Integral Unit	Affiliated Incorporated: Not For Profit	Affiliated-Incorporated For Profit	Other
1906-1939	0	0	0	1
1940-1959	2	0	0	1
1960-1969	17	1	0	1
1970-1979	17	2	1	2
1980-1989	27	9	1	4
TOTAL	63	12	2	9

Source: Compiled by researcher from: University of Alberta. (1989). Directory of centres and institutes. Edmonton: Author.

incorporated institutes and centres were established in the 1980s and mainly for liaison with industry. Some of the cases in point are: Alberta Microelectronic Centre (AMC) in 1982, Centre for Frontier Engineering Research (C-FER) in 1983, The Laser Institute in 1984, The Alberta Telecommunications Research Centre in 1985 (Now called Telecommunications Research Laboratories-TR Labs) to name only a few. Although these centres, institutes and research groups are at times funded in part by the University many are not. However, a number of them have funding from government, granting agencies, and industry. The statistics for institutes and centres established from 1990 todate were not available.

Federal Networks of Centres of Excellence (NCE). In 1990 the Federal Government established 15 research groups under the Networks of Centres of Excellence Program. These Networks are basically linking researchers from university, industry and

government teaming together on specific research problems in their field. These centres were spread across Canadian universities and involved researchers from both the universities and industry. They were funded by the Natural Sciences and Engineering Research Council (NSERC) and the Medical Research Council (MRC). Phase one of this program came to an end in September 1994. The networks have now been reduced to ten and the University of Alberta is involved in all the ten networks. These are: Canadian Bacterial Diseases Network, Canadian Genetic Diseases Network, Canadian Institute for Telecommunications Research, Concrete Canada, Inspiraplex, The Institute for Robotics and Intelligent Systems, The Mechanical and Chemimechanical Pulps Network, Micronet, NeuroScience Network, and Protein Engineering Network of Centres of Excellence. Most of these networks are in the engineering and medical fields although multidisciplinary research is carried out in the majority. Table 4 provides the current number of staff and students involved in these networks.

Table 4

Scientists, Students and Support Staff involved in NCE at the University of Alberta

Principal Investigators/Scientists	39
Support Staff	98
Graduate Students	45
Total	182

Source: University of Alberta. (1995). Proposal for enhancing the networks of centres of excellence program in Alberta. Unpublished report.

University Spin-Off Companies. A number of companies have been established as result of research at the University of Alberta. The University of Alberta

defines a spin-off company as

> any company which is established to develop and commercialize, directly or indirectly, technologies or processes, developed by the researchers at the University of Alberta. Most of these companies have been established by the researchers themselves or with the researcher as the main participant. (Unpublished University of Alberta Paper, 1993, p. 23).

In some cases the companies have been established as a result of a licensing agreement with the patent owner (researcher). Table 5 provides a list of companies and consortia that have been spun-off from the University of Alberta up to 1993. Table 6 is a summary by the researcher of information provided in Table 5 as well as additional information from 1993 to 1995. From Table 6 it can be seen that the establishment of spin off companies has been increasing over the years with the majority now having been established in the 1990s followed by those established in the 1980s. In addition to the 9 spin-off companies started in 1994-1995, there are three that are in the formation stages.

Table 5: University of Alberta Spin-off companies and Research Consortia

Name of Company	Year Founded	No. of Staff	Sector Activity	Other
Biomech Designs Ltd.	1982	1.0	Prosthetics	
Biomira, Inc.	1985	170.0	Biotech	Cancer Diagnostics and Therpeutics
Biotex Laboratories	1989	3.0	Biotech	
Boreal Laser Inc.	1988	8.0	Advanced Electronics	Development of Laser Products
CV Technologies Ltd.	1992	3.0	Biotech	Advanced R & D and commercialization involving Dr. P. Pang's research
Chembiomed	1977	0.0	Biotech	Company closed in 1991; technology moved to ARC
DB Robinson & Associates	1976	40.0	Petroleum Technology	
Gaia Software	1988	5.0	Geology	Software Products
Harding Instrument Co. Ltd.	1969	25.0	Petroleum Technology	Flow Measurement Equipment
L & R Wanc and Associates	1991	1.0	Canadian Coldbuster Energy Bar	Company contracts production to external suppliers in Alberta
Myrias Corp.	1983	6.0	Super-computing (now software licensing)	Company downsized and reorganized in 1990; now licenses software; hardware moved to U of A
Ovo-Biotechnica	1991	2.0	Dr. Saul's Canadian Designer Eggs	Company contracts its work to Alberta suppliers
Prairie Biological Research Ltd.	1984	8.0	Biotech	Research and Testing in Toxicology
Protein Software Inc.	1989	1.0	Biotech	Biomolecular Software
Raylo Chemicals	1983	56.0	Biotech	Contract R & D and production
SPI Synthetic Peptides Inc.	1986	14.0	Biotech	Commercialization of peptide technologies
SynPhar Laboratories	- 1987	100.0	Biotech	Owned by Taiho Pharmaceutical (Tokyo)
Technology Transfer Inc.	1990	24.0	Photographic Solution Recycling	Employees include sub-licensee staff
Tyler Research Instruments Corp.	1978	12.0	Medical Devices	
Not-for-Profit Research Consortia (Incorporated)				
Alberta Microelectronics Centre (AMC)	1982	30.0	Micro-electronics	Has operations in Edmonton and Calgary; funded by Province and Industry
Alberta Peptide Institute	1985	4.0	Production of peptides for research	Supported by MRC and AHFMR
Canadian Institute for Petroleum Industry Development (CIPID)	1992	3.0	International Training Centre for Petroleum Industry	Jointly owned by U of A and U of C; federally funded.
Centre for Frontier Engineering Research (C-FER)	1983	40.0	R & D and applications of technologies for energy resources	Funded by federal, provincial governments and industry
Institute for Stuttering Treatment and Research	1986	6.0	Stuttering research and treatment	Supported by private foundations and public donations
Telecommunications Research Laboratories (TRLabs)	1986	150.0	Tele-communica-tions R & D	13 industrial sponsors, 2 prov. govt sponsors; 3 universities
The Laser Institute	1984	15.0	Laser Research	Operations in Edmonton, Calgary, Ottawa; funded by Province and Industry
Edmonton Radio-pharmaceutical Centre	1977	8.0	Biotech	Production and supply of radioisotopes

Intellectual Property and Contracts Office
June 1993

Table 6

Establishment of University of Alberta Spin off companies and Consortia

Period	Number
1960-1969	2
1971-1979	4
1980-1989	16
1990-1993	5
1993-1994	9
1994-1995	9

Source: Compiled by the researcher from Table 5 and from data available in the University of Alberta documents: *Research Works* (1994) and *Research works*(1995).

Research and Development Partnerships at the University of Alberta

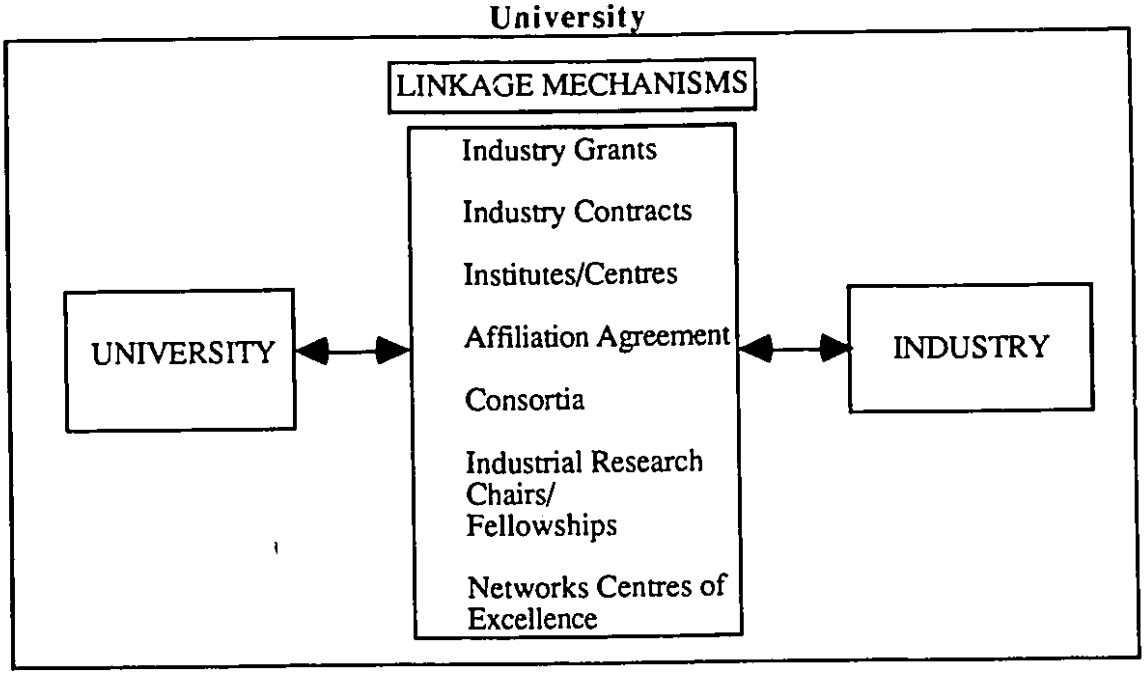
This section describes the types of partnerships or the mechanisms of collaboration through which the University of Alberta interacts with the private sector in research and development. Figure 4 provides a summary of these linkage mechanisms.

Predominant Modes of Collaboration

A list of industrial research awards for 1992/93 and 1993/94 and information from documents revealed the existence of the modes of collaboration between the University of Alberta and the private sector in research and development (R & D). These are illustrated in Figure 4.

Figure 4

Linking Mechanisms of University-industry R & D Collaboration at the University



Industry grants. Industrial grants are cash contributions from a company or an agency to University researchers which allow them to pursue research in areas of their own interest. There are no specific time limits for the completion of the research. This collaborative arrangement is sealed by an agreement between the University and the company. The agreement provides all the details of what the researcher will do, the contribution of the company, the matching contribution of the government agency such as NSERC or MRC and the intellectual property rights of those involved.

In 1993/94, for instance, there were 95 industry grants distributed among the different faculties as shown in Table 7 . The table also shows the origin of the collaborating companies whether Canadian or foreign.

Table 7

Number of Industry Grants and Contracts Awarded in 1993/94 Financial Year

	Industrial Grants			Industrial Contracts		
Faculty	**Total**	**Canadian**	**Foreign**	**Total**	**Canadian**	**Foreign**
Engineering	26	26	0	8	8	0
Medicine	24	15	9	13	5	8
Agriculture/ Forestry	22	20	2	5	4	1
Science	13	10	3	9	9	0
Pharmacy	7	7	0	1	1	0
Dentistry	1	1	0	0	0	0
Education	1	1	0	1	1	0
Rehabilitation Medicine	1	1	0	0	0	0
TOTAL	95	81	14	37	28	9

Source: Compiled by researcher from 1993/94 list of industry grants and contract awards.

Industry contracts. In University-industry contracts, the companies provide funds for specific or target oriented research. The contract specifies the areas where industry requires research to be done, what the researcher will do, the duration and phases of the research assignment, and the conditions of payment as well as the intellectual property rights.

In 1993/94, there were 37 contracts distributed among the different faculties as shown in Table 7. From Table 7 and an examination of the industrial awards list for 1993/94, the following features emerge:

1) Collaborative R & D links with the private sector are concentrated in the Faculties of Engineering, Medicine, Agriculture/Forestry, and Science in that order;
2) Most of the industry grants and contracts are awarded to individual researchers and few to research groups;
3) Only six research groups were involved in 1993/94 industry grant awards and contracts;
4) From the interviews conducted, most of these grants and contracts are researcher initiated while a few are industry initiated;
5) The time-line for most of these industry research grants and contracts agreements range from three to five years;
6) In industry grants and contracts, the agreement is between the company and the University Board of Governors.

Collaboration with industry through University research institutes and centres. The 1994 University of Alberta Research Policies and Services handbook states that

> the University has entered into a number of affiliation agreements with other centres and research institutes ... among other things, however, these arrangements and several memoranda of understanding set out the research arrangements between the university and the affiliating party. In most instances, these arrangements act as an interface between the university's applied research and industrial research and development. (p. 7-5-1).

According to this same policy handbook, *Memoranda of understanding* " do not involve financial obligations or specific targeted commitments ... and provide an "umbrella" to facilitate interaction between the University and the other party and can include

collaborative research and development projects, joint education projects, and technology transfer initiatives" (p. 7 - 5 - 1).

The University has entered into affiliation agreements with the following:

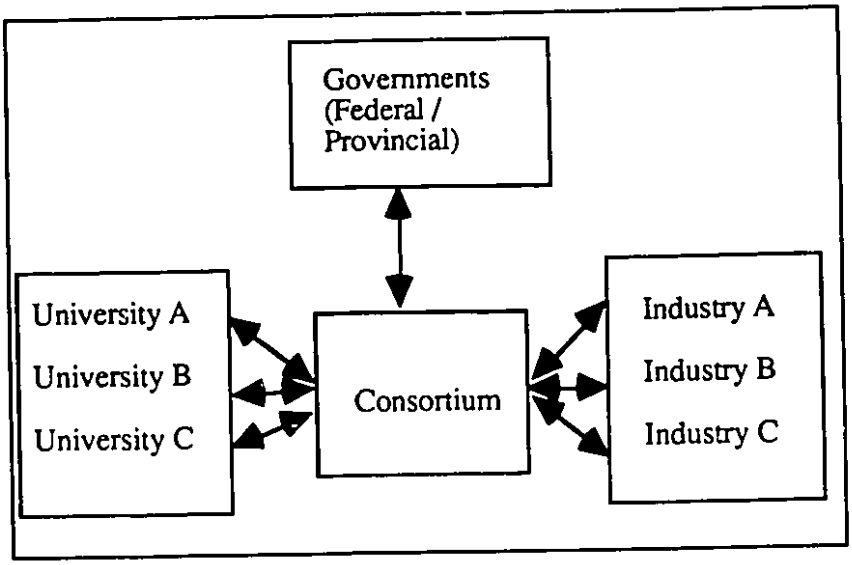
(a) Centre for Frontier Engineering Research [C-FER]; (b) Alberta Micro-Electronics Centre [AMC]; (c) The Laser Institute; (d) Alberta Peptide Institute, and (e) TR Labs.

Collaboration directly with industry through research affiliation agreements. The University has also entered into affiliation agreements with some of its spin-off companies for purposes of collaboration in research and development(R & D). Currently the U of A has an affiliation agreement with Synphar Laboratories Limited.

Consortium. In a few cases, the University has in collaboration with the private sector and government, established a consortium where the three sectors collaborate in R & D and a wide range of other specified areas. This arrangement is also sealed through affiliation agreements. Telecommunications Research Laboratories [TR Labs] is a very good case in point. It was a first telecommunications research consortium established in Canada in 1986 by the University of Alberta, Bell-Northern Research Limited and the Government of Alberta. It has since expanded to incorporate more members which include the University of Calgary, the University of Manitoba, the University of Saskatchewan, and the University of Regina. The federal government, the provincial governments of Saskatchewan, Manitoba, and 26 industrial partners are also members of the consortium. The consortium model is illustrated in Figure 5.

Figure 5

University-Industry Consortium



Industrial research chairs and fellowships. These exist in different faculties and are sponsored in part by the private sector and the different research granting councils. Agreement for the provision of these positions specify the percentage of time the chair or fellowship holder should devote to research *vis a vis* teaching. For example, in 1994/95 the faculty of Medicine has 25, Engineering 12, Agriculture and Forestry 3, and Science 2.

Industry Partners

This section of the chapter provides a description and analysis of the nature and location of industries that have partnership arrangements with the University. All the companies that participated in the study had research and development partnerships with more than one university. Some of these partnerships were with other universities in the Province; others were outside the province but within Canada, or with universities in the United States, Europe, and Asia.

Characteristics

An examination of the companies that have links with the University through grants and contracts revealed the following characteristics:

1) They range from small companies of fewer than 50 employees to subsidiaries of large multinational corporations with over 10, 000 employees.
2) They are fairly spread throughout Canada, although most of them come from eastern and central Canada.
3) A number of these companies are foreign.

Table 8 shows the status of companies and corresponding faculties in which they sponsor research through grants and contracts for the 1993/94 academic year. It can be seen that: (a) the Faculty of Medicine has not only the largest number of companies but the most foreign sponsoring companies as well; (b) apart from this faculty, the Faculties of Science and Agriculture/Forestry are the only two other faculties that have research links with foreign companies.

Table 8

1993/94 University of Alberta Industrial Grants and Contracts Provided by Canadian and Foreign Companies

Faculty	Canadian	Foreign	Total
Medicine	16	12	28
Engineering	18	0	18
Agriculture/ Forestry	14	3	17
Science	15	3	18
Pharmacy	7	0	7
Dentistry	1	0	1
Education	1	0	1
Rehabilitation Medicine	1	0	1
TOTAL	73	17	90

Source: Compiled by researcher from 1993/94 list of industry grants and contract awards.

Table 8 provides the status and location of the companies--the Alberta-based, other non-Alberta Canadian companies and the foreign ones. It is evident that: a) it is only the faculties of Medicine, Pharmacy, Science, and Dentistry that have more non -Alberta based Canadian companies; b) the Faculty of Engineering is the only one that has research links with more Alberta based companies than the rest of the Canadian firms that funded research in the faculty (12 Alberta based firms as compared to 6 outside Alberta).

Table 9

Location of Canadian Companies Having Research Links with the University in 1993/94

	Location of Canadian Companies					
Faculty	**Alberta**	**Ontario**	**British Columbia**	**Quebec**	**Total Canadian**	**Foreign Companies**
Engineering	12	4	1	1	18	0
Medicine	5	7	0	4	16	11
Agriculture/ Forestry	7	4	3	0	14	3
Science	6	3	1	4	14	3
Pharmacy	2	3	0	1	6	0
Dentistry	0	1	0	0	1	0
Education	1	0	0	0	1	0
Rehabilitation Medicine	1	0	0	0	1	0

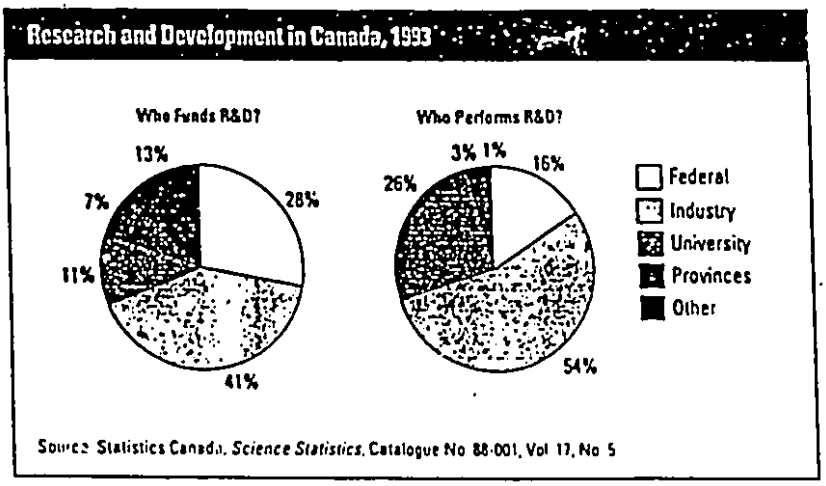
Source: Compiled by researcher from 1993/94 list of industry grants and contract awards.

Funding of Partnerships

The government (federal and provincial) still provides the bulk of research funding at the University of Alberta through the main research granting councils: the Natural Sciences and Engineering Research Council (NSERC), the Medical Research Council (MRC), and the Social Sciences and Humanities Research Council (SSHRC) with the private sector and others contributing the rest. Figure 6 illustrates the proportion of

Figure 6

Proportion of R & D Funding And Performance By Different Canadian Sectors



Source: Adapted from Government of Canada: Secretariat for Science and Technology Review, Industry Canada (1994). Building a federal science and technology strategy (p. 14). Ottawa: Supply and Services Canada.

funding of R & D in Canada by different sectors according to 1993 Statistics Canada. It can be seen from Figure 6 that industry leads in both funding and performance of R & D. This is followed by the federal government and other agencies with regard to funding. However, in performance of R & D, universities rank second to industry. Table 10, however, provides a picture of industry funding for 1993/94 through industry grants and contracts. Industry grants and contracts from these companies range from as little as $ 1,000 to as much as over $100,000. It can be seen from Table 10 that:

1) only three faculties: Medicine, Agriculture/Forestry, and Science had foreign industry funding;
2) the Faculty of Medicine received more funding from foreign companies than from Canadian companies;
3) the Faculties of Engineering, Agriculture/Forestry and Pharmacy received more funding from Alberta firms than from other non Alberta Canadian firms or foreign firms;
4) the Faculties of Science, and Medicine received more funding from non-Alberta based Canadian firms than from Alberta based firms.

Table 10

Funding Sources for 1993/94 Industry Grant Awards and Contracts to different Faculties at the University of Alberta

	Industrial Grants			Industrial Contracts		
Faculty	Alberta Firms	Other Canadian Firms	Foreign Firms	Alberta Firms	Other Canadian Firms	Foreign Firms
Engineering	450,210	177,000	0	217,000	0	0
Medicine	48,000	402,380	206,521	57,000	373, 604	1,519,640
Agriculture/ Forestry	407,123	93,750	6,639	114,000	0	49,000
Science	83,450	231,975	29,400	159,183	389,040	0
Pharmacy	80,000	168,723	0	175,000	0	0
Dentistry	0	140,650	0	0	0	0
Education	21,048	0	0	0	0	0
Rehabilitation Medicine	17,706	0	0	0	0	0
TOTAL	1,142,137	1,213,376	233,550	622,183	762,644	1,668,440

Source: Compiled by researcher from 1993/94 list of industry grants and contract awards.

Summary

This chapter has provided background information on the evolution and current state of university-industry research and development partnerships at the University. It was noted that from early 1980s, the University of Alberta began to take more interest and action in developing R &D collaboration with industry. Since the establishment of the Office of the Vice-President (Research) in 1981, other organizational units to support these endeavors

both at the central administrative and at the faculty levels have been started. Special note was made of the establishment of Intellectual Properties and Contracts Office (IPCO) and its detailed functions, and the university-industry committees in some of the faculties. It was also noted that research centres, institutes and research groups that focused not only in non-industry but also in industry research continued to increase in number as well. Further, more spin-off companies based on the University's research were established.

An examination of the policy environment indicated that the federal government had a number of programs that foster these R & D links. The provincial government's matching program which was hailed by the respondents had been discontinued. The only notable provincial program existent at time of the study was the Alberta Heritage Foundation for Medical Research designed to foster these research links. The University too had over the years developed policies governing these interactions with industry and the salient features of some of these policies were described.

Different modes of collaboration, the nature of industry's collaboration with the University, and funding of these partnerships were described. Noteworthy was the location of these companies--most of those linked with the engineering faculties were based in the province, while the medical and pharmaceutical companies linked with the faculties in the medical and pharmaceutical fields were based in the eastern part of Canada and a few were from outside the country. The high ratio of foreign funding to local funding was evident in one faculty.

CHAPTER 5

PERSPECTIVES FROM THE UNIVERSITY

This chapter provides the perspectives of fourteen researchers and eight central administrators on partnerships between the University and industry based on their participation in such partnerships. These perspectives are derived from their responses to the research interviews carried out with them. These include the reasons for their participation and the logistics, structures of collaboration, policies, environment of the partnerships, benefits, problems, challenges, and lessons derived from these experiences.

Initiation of Partnerships

How did the different partnerships in which the interviewees were involved start? This section describes how some of these research partnerships began.

Avenues for Initial Contacts

The experiences of these participants indicate that the initiatives to establish collaborative research contacts were taken either by the university researchers or industry personnel. Some of the university researchers stated that the industry contracts or grants that they had were initiated by themselves. Others said they were approached by industry. The main avenues for the initial contacts for these collaborations were as follows:

Researchers' visits to industry. Some university researchers were invited to visit industry and give a seminar on areas of their expertise that were of interest to the company, and from there the company developed further interest which eventually led to the decision to collaborate.

Presentation of papers in conferences. For others, interest by the companies developed after a presentation of a paper in a conference which attracted the attention of industry personnel present.

Industry visits to campus. In some cases industry personnel visited campus and subsequent discussions and dialogue resulted in the collaboration.

Sending unsolicited proposals to industry. Here the researchers sought funding from industry in areas they felt were of interest to industry. If companies were interested, they would pursue the issue further which may eventually lead to collaboration.

Industry advertising for proposals from University researchers. Some of the collaborations came about as a result of University researchers responding to companies' requests for research proposals on particular areas of interest to the companies.

Past contacts or friendships. Some of the initiations came as a result of old friendships or professional or academic connections between the university researchers and industry researchers and administrators and with the development of mutual interests in specific areas research, these eventually resulted in collaboration.

Reasons for Research Partnerships

Interviewees described their reasons for engaging in collaborative research with industry. Their reasons can be grouped under four themes: (a) Academic or Scholastic reasons, (b) resource or financial reasons, (c) society related reasons (social problem solving), and (d) practical application of theory.

Academic Reasons

The reasons provided under this category by faculty members relate to their traditional role as scholars within their traditional community. Emphasis was placed on the freedom to explore and go where their minds lead them.

Pursuing visions/dreams of their research. Apart from performing needed research for industry, 10 respondents mentioned that these partnerships provided them with funding to fulfill research dreams of their own. This was well expressed by one researcher, who stated:

> I think that from what I have seen in our faculty, the academic motivation is number one. I think people are genuinely interested in the generation of knowledge which is useful; it certainly has a use in the short term, that is, to the contracting agency or company; but I think also that it will make a genuine contribution to knowledge.

Another added:

> I guess intellectual curiosity is the main reason. These projects are part of long term research activities that I find intellectually interesting, and that is the major motivation; that is the only way to keep interested. So it is not predominantly a financial incentive. These contracts provide funding for graduate students, for research assistants, for materials and supplies to keep labs going, so they provide resources that aren't available otherwise. But the major incentive is intellectual curiosity.

In expanding on this theme, one faculty administrator said, "The motivational side from the academic staff, the research directors, I think is simply to be able to pursue some of their visions or some of the dreams that they have in terms of research."

Building an academic profile. Apart from the provision of funding to carry out further research in areas of their own interest, some researchers acknowledged that industry provided funds for other related activities that helped to boost their academic profiles. One researcher stated it clearly:

> It provides opportunities to do other things. Most research grants and contracts, for example, have a component of funds to travel to scientific conferences and meetings to present research papers and so on. This is part of the academic profile that it helps to build, and it builds that for the individual and for the faculty.

There is another dimension to building an academic profile, what one researcher called "ego satisfaction."

> All academics have egos, and a lot of times doing work with the private sector brings with it some kudos. There is always the perception that industry is more efficient, industry does it better. If industry is coming to us, it must be because we are doing it well.

Enhancing teaching. Four researchers pointed out that learning about the kinds of problems that industry faced was useful in teaching students:

> As an engineer and a professor, one learns what the problems of industry are, and can bring some of these problems, as examples, during teaching. So you cannot just separate the teaching and the research, because one is reliant on the other.

The academic reasons provided above the above researchers involvement in university-industry research do emphasize, therefore, curiosity driven research, enhancement of the researchers academic profiles and their teaching.

Resource or Financial Reasons

The reasons discussed under this heading emphasize the importance of both financial and material resources that are necessary for research, whether applied or basic.

Source of research funding. It was noted by both administrators and researchers that research grants from the federal granting councils were inadequate and therefore university-industry research links was considered as a source of extra funding for research.. As one researcher stated "It is a way of supplementing funding that is not enough," said one respondent. One academic administrator (an Associate Dean-Research) put it this way:

> From the perspective of the researchers, the linkage is to get more money to do the research they want to do. Research is an expensive exercise, and the links provide funding because the granting councils don't have enough money. So it allows us to do more research here, to employ more people than we could if we were just dependent on funding from the Medical Research Council or NSERC.

The emphasis seems to be on acquisition of funds to further academic work . One faculty administrator, for instance, stated:

> One thing we won't do in this faculty is what I will call pure service work. We are really interested in money that will allow us to do the basic and applied research that will move the forefront forward. So what drives us to get the money is not just to churn out data for some company, but rather to be able to ask the scientific questions that the researchers here want asked and to be able to answer them.

Another stated:

> We have had some spikes of support from central administration...but I think everybody recognizes that central administration just does not have the resources to support us either. So we have the choice of doing research or not doing research, and I think we have all had to learn that the ivory-tower approach is going to leave us with not doing research. Our research is expensive to do, it requires physical resources, and we can't have those without financial resources, and I think people see associations or contracts with industry either as a way to get money which they utilize for doing other things or in some cases to actually do the work they want.

Thus even where funding is the main reason for seeking research collaboration in the first place, the underlying motive nevertheless remains the pursuit of basic research.

Updating equipment and facilities. Industry research links are seen as an avenue to update research equipment and laboratories. One academic administrator put it this way.

> We see this as a way of getting our laboratories modernized with industrial help. It is something that we have not been able to do with university help. We get a few dollars for it, and that helps in times of current budget stress.

Commercializing research results. Four researchers stated that were interested in developing their research ideas and findings into marketable products and collaborating with industry was one way of doing this.. As one researcher stated,

> my motivation to get involved with a company is that if we just published our discovery without taking time to patent, that would kill the opportunity for that compound to ever be marketed. It costs a lot of money to bring a compound through clinical trials. We are currently in the development phase. We couldn't finance that through MRC or any other government-funded agency. We have to form partnerships.

In summary, the financial reasons provided for involvement in university-industry research seem to emphasize the provision of research and teaching facilities as well as additional resources for the researchers to do more research than would otherwise have been possible without industry funding.

Social Problem Solving

These reasons focus on providing solutions to societal problems or related matters.

Solving problems that affect society. Eleven respondents saw collaborative research with industry as a way to help solve problems faced by society, be they industrial or medical problems. These researchers believed that their research, if developed further in collaboration with industry, could contribute to solving some societal problem related to their line of inquiry. One researcher stated: "My motivation in science is that I would like to do something that has a significant benefit to society....My motivation is to come up with a treatment for a disease that affects millions of people."

Practical Application of Theory

A number of respondents emphasized that doing industrial research provided them with an opportunity to do applied research in the medical and engineering fields. As one researcher put it:

> In pharmaceutical research the object is to discover drugs that will improve a certain pathological condition, and I would just love to be able to say that I found this special drug that is going to be on the market for the next 20 years. As a pharmacologist I am interested in drug development; and industry, of course, has exactly the same objectives.

Another stated:

> In terms of partnerships with companies or linkages or contract work or whatever variety it took, the thing that motivates someone is, first of all, the ability to use their skills in a setting where they could see a very practical application of their work. And so if you are a university professor in engineering and you have developed some nice fundamental work, theories, some computer simulations, new, ways of doing things, part of the satisfaction to see that transferred to an industry, to see the practical application on a large scale or even on a small scale.

In summary, the reasons provided by the University researchers for their involvement in industry research have ranged from curiosity driven research, practical application of the theories developed earlier, opportunity to solve societal problems such as diseases, and enhancement of their teaching.

Policy Framework

As was noted in Chapter 4, policies play a crucial role in enhancing or hampering the development of university-industry research and development partnerships. These policies which may be either internal (institutional) or external (outside the institution) determine the nature of the environment in which these partnerships develop and function. This section describes the perspectives of university respondents on the internal and external policy environment of the University, followed by their assessment of specific university and government policies that have a bearing on these partnerships.

The Environment of University-Industry Operations

Respondents expressed their perception of the environment in which they participated in collaborative research and development activities. They commented on the situation as they saw it within the University and outside the University. Their comments can be considered under two areas, the internal environment (university environment) and the external environment (outside the academy).

The internal environment. Eleven respondents acknowledged that the environment within the University for collaboration with industry had improved over the years. Some of the terms they used to describe this environment were: "conducive, "more open and cautious, "positive environment," "open and optimistic," "very healthy environment." There was recognition that the university was doing its best to make the environment conducive for collaboration with industry. One researcher explained:

> I think the University is trying to make it as conducive as possible. They may not have the right mechanisms of attracting the links at the moment, but once the link is established, I think they are not putting up any roadblocks; they are really going all out to make it conducive.

An example was cited of the media attention given to the signing of some of the university-industry contracts and grants in the recent past where the University President, the city Mayor, the Minister for Advanced Education, and corporate executives were

present. This was considered good exposure of university-industry activities. The establishment of structures to facilitate these links, and the increasing positive change of attitudes by faculty members towards industry had led to more conducive environment. In the words of one faculty administrator:

> It is a *positive environment* [italics added] overall. I think that universities have a tolerance and a better understanding of what is happening in industry. There are still people who don't, but I think the individual researcher or the individual academic staff member has a better appreciation of industry.

In reference to university structures and faculty administration, one researcher remarked:

> This faculty has a very *positive attitude* [italics added] towards the collaboration with industry. They encourage it. When it comes to the university, we have had an office of research which is not very old. Now we have the Intellectual Property and Contracts Office and the Grants office. There have been some difficulties in the Intellectual Property and Contracts Office not moving contracts as fast as we would like. However, I think it is very healthy, just to summarize it, both in the department, faculty, and the university. It is a very healthy environment to work with industry.

The positive attitude towards industry is not restricted to the orientation towards researchers' activities but also includes the attitudes towards industry funding of research as well. One researcher explained:

> At one time we used to look with jaundiced eye upon some of the industrial money. Today I think industrial money carries a lot of respect, and people realize it is not easy to get and that industries are quite selective in where they are putting their money.

Two respondents , however, felt that the environment was not as conducive as it should be. There were still some skepticism and tensions both within and outside the university regarding these partnerships. A senior University administrator commented:

> I don't think it's real positive. There's a lot of skepticism in industry that this university has not been particularly responsive, and has people who just don't have the time of day for it, think it's the wrong thing to do. There is a growing awareness both in industry and the university that this is important and an exciting area to look at.

Despite the fact that the environment had improved overall, one faculty administrator noted that there were tensions related to some of the dimensions of these partnerships: As one head of department and researcher explained:

> There is also tension between the academic entrepreneurs and the central administration. The tension comes in when you talk about overhead costs. The academics tend to see overhead costs as a bottomless pit where the overheads disappear, and there is no accounting. There is no accounting provided to the university community of what the costs are, and so there is a communication gap.

There was concern expressed about the location of some of the spin-off companies which were still located on campus. One of the researchers explained:

> Right now we are mixed around campus. I don't know really if that is ideal, because if you are in a department, the department might decide it wants the space that the company has. That is why I believe in an incubator facility.

In summary, then, it would seem that the University environment regarding university-university industry links has improved over the years, and there was optimism expressed that it could be made more supportive than it currently is.

The external environment. While acknowledging that the internal environment was good, a number of respondents noted that the external environment was not as positive. This was attributed to reduced research funding by government and the weak research culture of Canadian companies. This is how one faculty administrator put it:

> The internal environment is excellent. The external environment we have to work very hard at. It is not as good as I would like. It is the agenda of the government, a mentality, a philosophy that makes it extremely difficult. So I know clearly all these cutbacks are going to hurt us. We lose people, we lose infrastructure. One of the things I'm most worried about is making sure, as we go through these budget cuts, that it doesn't destroy everything we have built up here in terms of making this a first-rate research university.

Regarding the weak research culture of Canadian companies, it was noted that these companies had the attitude that if they needed any expertise or technology they would buy it even if it meant buying it from outside the country, rather than develop it within the country themselves. These companies do not, therefore, "see research and development as a central issue in their long-term success," as one researcher explained. This researcher pointed

out, however, that those exceptional companies that had overcome this attitude and saw research as important, realized there were many things they could do in cooperation with the universities. However, for the others, as one faculty administrator explained,

> Until they identify research as important, there is no hope of working with the university. So that is an external environmental issue, that companies that do not see research and development as a priority can't work with universities, because the university is not there as a short term consultant. The university is there for long term development.

In summary, most of the university researchers felt that the environment of university-industry research collaboration was conducive, and that it had improved compared to the past. Some noted, however, that there was still an element of suspicion and skepticism by some within the academy about this kind of research involvement for industry.

Policies

Policies play a very important role in shaping the direction of any program. University-industry research is no exception. Some respondents commented on the university and government policies on university-industry partnerships.

University policies. Based on their experiences over the years, university researchers reported that they were happy to see policies in place as there was some time in the past that these policies did not exist or were not elaborate enough. These policies were developed from the time the first R & D partnerships were initiated and they have been improved over the years as the number of these collaborations increased.

Twelve respondents felt that University policies were generally favourable. As one researcher noted:

> In general I would say that they are probably good policies to have in place, and they serve as valuable guidelines. Sometimes I think that we have experienced frustration with them because things move very slowly.... In general I think that they work pretty well.

Another faculty administrator said:

> We have a pretty good university-industry-relationship policy in place. It is fairly strict, and some people feel that it is negative from industry's point of view.... You have to strike a very careful balance.... We are re-evaluating some of the guidelines because we want to make sure that we protect the university people: the students, the postdocs, the faculty, but at the same time we want to make this a good environment for industrial research. And so there is a very fine balance. But there are certain things that we will not allow, and that is we won't allow companies to hold up data from publication, we won't allow students to be involved in projects where their thesis could be jeopardized because the research may be of commercial value and other things.

Some of the policies that received favorable comments or were given as good examples are:

Policies on royalty arrangements/patents/intellectual property. Policies on royalties were considered fair because the patenting of the intellectual property allowed the researcher the option of letting the university handle it, and hence sharing royalties accordingly or pursuing the patent on his/her own and paying one third of the royalties to the university and two thirds to him/herself.

Policies that protect the University from liability, as well the protecting graduate students and university researchers. As was noted in Chapter 4, whereas the university had provided policies in the form of general guidelines and procedures, the faculties were expected to make more explicit guidelines within their faculties to govern the staff relationship with industry. These faculty policies must be in accordance with the university's general policies. Respondents from two faculties, however, felt that the policies in their respective faculties were too strict. One of these stated:

> We have very strict policies in the faculty on ownership of shares, and the company that you own shares in cannot come back to keep supporting your research. Well, in the spin-off companies this is becoming a problem because many times when these companies are spun off from the university, the investigators that are involved need the university on a full-time basis and often retain part-time appointments, but partly because they are going into a gamble . . . and the company wants to fund it. In fact, they are not allowed to because they own shares . . . . I think we have got to examine some of these areas . . . It is an area that needs to be looked at.

Some respondents were concerned that overheads were not received favorably by industry, and that the details on how they were arrived at were not clear. One faculty administrator expressed it this way:

> I sometimes get a little bit worried because I think that, for example, the 40% overhead rule, although it is very hard to get detailed information, and perhaps rightly so, that 40% overhead rule has a variety of interpretations in its application; and that may be good as well, because it should depend on the type of work. But I think that there is a little bit of a tendency in the interpretation of the rules to kill the goose that lays the golden egg . . . . So I am concerned that sometimes the rules are applied too rigorously in the short term.

Some researchers supported the charging of overheads but complained that there was no explanation as to how the overhead costs were used and found lack of communication on this matter as a problem rather than the overheads themselves. One faculty administrator stated that industry and those opposed to charging of overheads needed to be educated on this policy. One researcher complained that the university did not have any policy to encourage start-up companies by faculty:

> Nobody has sat down, I think, and made a policy that would work, one that would make it easy for companies to start and spin off from the university. I think there are people at the university that believe that shouldn't even be done.

Indeed, one researcher considered the encouragement of spin-off companies by the university as a conflict of interest noting that while it fostered economic development it did not foster academic programs:

> So if you are saying to the faculty members, develop spin-off companies, you are putting them in a situation where they are no longer available to fulfill a major part of the university's mandate, which is education, teaching, because what you get at institutions that pursue this, is professors buying release time so that they are out of the classroom and they are no longer teaching. They are on academic staff, but they are putting sessionals into the classroom or somebody into the classroom to fulfill that obligation, and that develops economic development; it does not help the academic purposes of the university.

One researcher felt that should be the choice of the individual researcher to set up a spin-off company or not, noting that setting up such a company based on the product of one's research takes a lot of time away from research work. Rather than establish a

company, therefore, he preferred instead to collaborate with an interested company in developing a product out of his research work:

> Some people might think you do better by trying to set up a company, but there is a lot of work in it too. It takes away from the scientific work. The way it is set up now is that we can concentrate on the science and still get good support from the company and that is what I want to do.

The importance of having policies that were fair and that would encourage collaboration was very much emphasized by theses university respondents. One researcher, for instance, noted:

> The people in the university administration are saying we would love to see you get a nice research contract and the same time the faculties want you to get these research contracts, but they are also being very restrictive in some aspects. I think we have to improve our policies in this area.

Another researcher seeming to summarize the thoughts of others remarked: "If we really want these people to get involved this way, we should be looking at how we can encourage it, and our policies should not be so restrictive that we can't get it done."

Thus, in brief, the current University policies on university-industry research collaboration were positively considered by the respondents although as a number of the interviewees noted there was still room for further improvement.

Government policies. Some of the respondents were critical of the government's approach, both provincial and federal, to the whole area of university-industry partnerships. Some lamented the loss of provincial matching grants, which used to match industry funding for university research. Regarding this, one faculty administrator stated:

> The loss of matching grants has cost our faculty a lot of money .... I am absolutely concerned that we lost hundreds of thousands of dollars simply because the companies wanted to see a commitment on Alberta's behalf as well as on our own behalf.

Another researcher added:

> The provincial government would like to see more interaction but it is doing nothing to facilitate it. So in the case of the provincial government, at least in the fields where I work, which is science and engineering, there is nothing happening. The oly provincial involvement in trying to foster

> collaboration is in health sciences. In all other areas they are doing relatively little to foster collaborative research.

One respondent noted that there was no coordination between different provincial government departments so that sometimes they had policies that were counterproductive to one another in this area. Federal government programs such as the IRAP, NSERC, MRC and the AHFMR programs for university-industry research links were lauded by the respondents for their facilitative role. One researcher for instance stated:

> The federal government agencies are doing more. The Natural Sciences and Engineering Research council has several programs that support collaborative research with companies, and those are, I think quite effective in encouraging these activities. They provide and incentive for academic staff at universities to develop linkages with companies, and they provide incentives vice versa, for for companies to interact with universities because they provide matching resources.

One researcher commented on the role of AHFMR:

> In Alberta, we have invested a great deal of money through the Alberta Heritage Foundation for Medical Research, to make medical research a priority, so that it is of high quality. We need some of the industrial partnerships now to reap the benefits of the investments the government has made ten years ago. I am not afraid to say that we can compete internationally. Our science is competitive on a national and international basis, and that is why some of the industries are coming here.

Researchers in the pharmaceutical and medical fields lauded the federal government's Bill C 91 which mandates pharmaceutical companies that operate in Canada to spend part of their revenue in basic research. Universities have, therefore, benefited from this policy.

Organizational Structures

The need to have administrative structures for coordination and facilitation of partnerships between the two sectors has been emphasized in the literature. The respondents commented on the current structures for these partnerships between the university and the private sector with regard to research and development activities. These structures ranged from the Office of the Vice-President (Research), the Intellectual Property and Contracts (IPC) Office to faculty structures such as the offices of Associate

Deans (Research). Their responses ranged from positive to negative comments about these structures. Some were satisfied with the existing structures while others were not. Some even questioned the role that they played or were perceived to play.

Central Administration

Some respondents felt that the current structures at the central administration level were adequate, except for needed improvements in their operations, as will be evident from their comments: "I think having a VP Research is good for a university which is established to do research and teaching. I have a feeling we are getting improved services or improved representations." The following comment by one of the researchers further illustrates the perception of these respondents:

> My impression is that we have a reasonable administrative structure within the University. We have a very good, knowledgeable, and understanding VP of Research. We have an excellent Associate Dean of Research in the faculty .... We have the Intellectual Property and Contracts Office. There have been problems with that office .... Somebody who is very knowledgeable in this area should take the leadership role and help organize them in the office ... the new V.P. of Research has taken a very strong role initiative to reorganize that office, and we have appointed a new director.... I think that was a very positive step and I think it will add another dimension to it .... My concern I guess, within the university structure is, is there adequate reward for that office doing good work? I say reward because may be we should look at a percentage of our overhead dollars that come to the university to go to help support that office.... Some of that overhead should go directly back to the IPC Office so that they have the incentives to go out and get these contracts. There should be an incentive, or an extra incentive for getting contracts for that office.

Comments on the Intellectual Property and Contracts Office were quite common. One respondent noted that the IPC Office was discharging some functions which he as a researcher did not have time to do, stating:

> I recognize that the University has put a lot of work in the IPC Office in administering all the correspondence regarding the patents, and we have had worldwide patents, so we are dealing with 30 or 40 patents in different countries. A lot of that administrative work was done by the IPC Office, and I appreciate that. I don't want to be doing that when I have got other things to do.... I want to get on with research.... I don't want to be tied. But, on the other hand, that aspect can be improved.

Inadequacy of structures. Whereas some interviewees supported the need to have these structures, one researcher felt that the structures, and especially the IPC Office, should be reduced in size. He felt this office was

> a total waste of money. All they do is impede any connections. . . . I used to be on their committees, but they don't invite me any more because every meeting I started saying, "This is a waste of time," and it is . . . . They make sure that the arrangement is allowed according to University rules. That means that if I make a very big discovery and I make a hundred million dollars now because of this, I must by law give the University 33% of that money, and that is the only thing these people should worry about. . . . They should just protect the University from liability, make sure that the contract protects me and the University, and make sure that the university gets some benefit because some of these discoveries are made here. . . . You only need two people: You need a lawyer and a secretary.... God, they must not expand! .... Then they will go and start beating on researchers' doors saying, "You had better go and get a contract, get a contract, because if not we can't get any money."

One faculty administrator, although appreciating the role played by the IPC, felt that they should reduce the number of staff:

> Centrally, I think we have too much administration. I think that there should be ways of streamlining and avoiding having so many people over in the Research and the Intellectual Property Office. They have just appointed a new Director of Intellectual Property and Contracts. I think in this time of fiscal restraint at the university, it would have been good to have one Director of Research Services and Intellectual Property and Contracts .... Research contracts is really a bureaucratic function, and they get all the information in and distribute it, and that is good. I think it is valuable and needed.

Some respondents pointed out that the Intellectual Property and Contracts Office needed more resources in terms of funding and personnel. One researcher put it this way: "The Intellectual Property and Contracts Office is seriously understaffed. They need sufficient personnel." Another added:

> The staff at the IPC Office can't handle the workload .... I don't think it is the fault of the individuals working in that office. I think those individuals work very hard, but they are individuals who by and large don't have a travel budget, so if I'm dealing with a multinational they can't help me visit this company; they themselves can't go to visit the company.

The widely differing views of IPCO seems to be based on these researchers' experiences and interactions with the staff at IPCO. As noted some researchers opt to

pursue these research links on their own and rarely require IPCO services except when it comes to finalizing the agreements through the University as per the University regulations. Others reported that they did not wish to spend their time pursuing administrative matters pertaining to these partnerships but would rather spend that time doing research and teaching and thus their appreciation of the role this office plays.

Faculty Administration

Very few respondents made any comments about structures within the faculties that have university-industry links. One positive comment has already been presented, a comment made by a researcher about his satisfaction with the role of Associate Dean of Research in a faculty. One Associate Dean of Research, however, expressed the need for more resources in the faculty:

> I would love to have someone here who will spent full time taking stock of the research that's going on. We have over 300 research labs in this faculty...some one should be going through all that research, seeing what is marketable, what might have potential, and then bringing it to the eye of various companies. I know about some of it, and so when the opportunities are right I mention it, but we don't do it in any sort of organized way; it's hit and miss. The idea was that one of the people in the IPC office was supposed to spend, say, three mornings a week here doing some of the things I just talked about. Well, they don't have the resources to have anybody doing it.

Support Role of Structures

From the respondents' comments about current structures, there were mixed feelings about the role of these structures. While they were considered essential, some questioned their size, and others their facilitating role. As has been noted above, one respondent felt that these structures "impede any connections." Most respondents reported that the contracts or grants that they had with industry were obtained out of their own initiative and not through the help of the existing structures. One researcher explained:

> I think the less structure between the researcher and the client or sponsor, whatever one wants to call it, the better ... because in my experience I have not yet found a contract that has been initiated by the administrators or whatever one calls them. It has been always initiated by myself .... The structures are already too many, and sometimes these bureaucratic structures

> are not very helpful. There are requirements to have some sort of structure for administrative and legal requirements and spending money. But I think this notion that they are facilitating is ... blown out of proportion. Maybe the structures can be helpful to junior faculty members, but that I am not quite sure of either. Sometimes the perception is that too much administrative structure is a deterrent to the obtaining of a research grant or research contract.

Another researcher noted that the University administration played a secondary role in these partnerships and was not a major player in linking University researchers to industry:

> These contracts have come about due to contact with companies, and that is outside of any university framework. So my personal experience is that the university plays an administrative role. It circulates requests for proposals; it circulates information on grant funds, which may or may not be complete; but it is not a primary conduit for contacts with companies. The major way that companies contact academic staff members, in my experience, is one to one. Any company that knows its interests and its field can find out who is potentially qualified to help them. So the university administration plays a strictly secondary role in developing contracts. They help in providing a legal framework, they provide administrative support, but it is strictly a supporting role and not a leading role, in my opinion.

One continued further on the same theme:

> The idea of somebody in central administration working to increase contract revenues to the university is something that I am not sure is feasible. There are things you can do to lead the university and lead the faculty members into being more entrepreneurial, but that is the role; it is a leadership role. You are leading people to do things, and it has to be approached that way. Whether the university at present has any structures in place that actively encourage faculty members to do that, I am not sure. Certainly in terms of seed money and so on, I don't see anything, in terms of assistance and developing contacts .... There is no structure that recognizes how these contracts come about and that is a concern.

Thus some researchers did not see any leadership role in the current structures. As has already been pointed out above, the significance of one to one interaction between the researchers in both sectors was very much emphasized by the respondents as having been the impetus behind the existent partnerships.

Benefits of Collaboration

Respondents addressed the question of benefits as well, what the outcomes of their collaborative research for industry were. These benefits ranges from the researcher's

personal satisfaction from engaging in these collaborations to societal benefits. These benefits reinforced their motivation for further involvement in these collaborative research links. These reasons are: (a) facility development, (b) faculty development, (c) student development, (d) instructional development, and (e) societal development.

Facility Development

Updating of laboratory facilities and upgrading of equipment had resulted from these links. As one respondent put it:

> We have been able to have better labs. For a number of years the labs were being subsidized by research grants because the university did not have enough money to run them, so the money was helping the students in terms of better labs, better experiments, better equipment, better resources for these labs.

This is related to one of the motivational reasons mentioned earlier in this Chapter.

Faculty Development

It was noted because of programs that encouraged university-industry links played the university had been able to attract and retain staff. One academic administrator explained: "They allow us to really do the research and to attract people here, to keep people here, to retain people here who are excellent researchers." All university respondents agreed that their research links with industry had provided more funding for research. Further, research partnerships often provide funding for researchers to attend conferences. As one researcher put it: "I get a really very good inside view on the state of the field and that comes because I go to the conferences that they sponsor."

Student Development

Some respondents repoted that the major portion of funding from these research links supported the majority of graduate students in most of the faculties where these links existed.

Instructional Development

Five researchers stated that having these links provided them with an opportunity to do applied research and also provided them with experiences from the practical field that would enrich their teaching. One researcher stated:

> I think the applied nature of research feeds back in many ways. . . . You go out and see how it is applied in industry. But at the same time it gives you exposure to industry; it enriches your research; it enriches your teaching.

This benefit is related to one mentioned earlier as a motivational reason for involvement in university-industry research.

Societal Development

For some of the respondents, University -industry R & D partnerships enabled the researchers to research and address problems that faced society and thus help in alleviating some of these problems. One researcher for instance visualizedthe satisfaction that he would feel after "coming out with a new drug to save millions of people". Another researcher noted the satisfaction that he obtained on having contributed to solving a problem faced by industry. As one researcher put it: "One cannot overemphasize the contributions of solving the problems, the simple intellectual satisfaction that one tried to solve a problem and was able to contribute to the solution. It is a very satisfying feeling that one gets."

The funding that faculties with industry research links have been able to attract has helped to support not only graduate students, but also research associates and technicians, and to generate jobs in the Edmonton economy.

Problems with Partnerships

From the inception of these collaborative relationships to the actual operations thereof, interviewees described some of the obstacles and problems they encountered in their involvement in university-industry links. Some said that they had not experienced any

problems at all, whereas others said that they had. Some had problems on the university side but no problems on the industry side.

One researcher who said he had not encountered any problems stated:

> I think I have been quite lucky that I haven't had major problems. People worry about publications being held up, but I have never had a company hold up a publication. They have always been quite quick to review and quick to get them back so that you knew what was going on.

Another, referring to the part played by the Intellectual Property and Contracts Office, noted that he had always had good interactions with the persons handling his contracts.

With regard to problems encountered by the interviewees, these ranged from organizational problems to conflict of interest issues relating to engagement in these R & D activities. These are described as follows:

Organizational

Organizational problems are those that deal with the administrative and procedural matters of these partnerships. Two of these problems were mentioned most frequently and these related to the University bureaucracy and to the time taken to finalize research agreements.

University decision making processes. Some respondents mentioned the *bureaucratic* nature of the university administration as being a problem. One academic administrator put it this way:

> There was a time when the University had great difficulty in being able to reach a final decision. It is one of the curses of democracy, I guess. It is very hard to find who has the ultimate authority. I remember a couple of years ago being in a very frustrating situation and saying to someone that if I had $10 million today and wanted to give it to the University, I probably could not do it in 24 hours. It would take too many questions, too many committees, and too many boards to get a final decision for me to be able to do that. Everything here is long-term negotiation, and I think that needs to be shortened for these sorts of business purposes.

Time taken to reach agreements for contracts and grants. Some respondents complained that the time from the initiation of an industry contract or grant to the time it was signed was unnecessarily long. This was indeed the most common complaint. One researcher summed it up this way:

> The frustrations that I have had are the excessive amount of time taken to reach an agreement. This is not only through the IPC Office; the problems also lie elsewhere in the central administration. And if I can be critical of central thinking, the University, I feel, has looked at every discovery as a way to make a large amount of money. They are afraid that someone will pick this up and make a zillion dollars, and they will get nothing. And so they negotiate and negotiate, and things go back and forth through lawyers until people get tired of it. Some of these agreements have literally taken years to negotiate. It costs a lot of money to keep a lawyer's meter ticking. I think that the University needs to learn how to do business.

Pressure to Loosen up Conflict-of-Interest Regulations

The issue of conflict of interest, which is common in the literature on university-industry collaboration, came up as one of the problems encountered by academic administrators and researchers. One academic administrator stated:

> There are certain people who are working with industry who feel that we're too restrictive. . . . Well, there are people who would like us to do away with these conflicts of interest, just open the whole thing up. So that is another problem . . . . There are people who would really take advantage of the situation in order to better themselves financially, and we have to make sure that we separate personal financial rewards from, say, the lab rewards and faculty rewards . . . . That's an area we have to be very careful of.

It would seem, therefore, that problems range from structural, process related, to attitudinal, and most of these mainly within the academy.

Challenges to Partnerships

Interviewees addressed the challenges that they felt need to be overcome in order to enhance collaboration between the two sectors and to make these partnerships effective. These challenges can be grouped into five main areas: (a) fostering positive attitudes; (b)

bringing the two sides together; (c) elevating research excellence; (d) marketing; and (e) the need for planning.

Fostering Positive Attitudes

Respondents reported the negative attitudes that prevailed in both sectors about each other, as well as about collaboration, as some of the important obstacles to be tackled. These include the following three:

Changing industry's perception of the University. Some respondents felt that industry's old attitude of the university as an ivory tower still prevailed to some extent. One researcher commented:

> I think the major challenge is the perception by industry of the University. It is still the old cliché of the "ivory tower": People do irrelevant work. You see it from idioms such as "This is an academic discussion." It means that it doesn't have any use.

Attitude of older faculty members opposed to industry links. Related in some way to the attitude by industry was the attitude of some of the faculty on campus who are opposed to university-industry links. This was considered one of the challenges. One researcher noted, for instance, that from his experience in the department, the younger members of faculty were more willing and eager to go out and work with industry than were the older faculty members. A faculty administrator added:

> There are a lot of people in the university who believe we shouldn't be working with industry. They believe that an academic environment should be simply curiosity driven. People should go wherever their minds lead them and not because of a product of interest to a company. . . . The fact that a very small fraction of the faculty are involved with industry, . . . that is a problem.

Bringing the University community along. Bringing the university community to accept university-industry links as one way of disseminating knowledge was considered a major challenge by one senior University administrator:

> I suppose the major challenge that I see is bringing the university community along, . . . getting the university community to see this as a legitimate, viable form of dissemination of knowledge. And that means

> looking at the reward systems; it means changing the way that we view how we disseminate knowledge; it means providing linkages for them, information for them.

With respect to this theme, one faculty administrator welcomed the divergent views on involvement in university-industry research as healthy:

> A university is going to have people with different opinions. If we didn't I'd be very worried. So I understand them all, I listen, and I take what advice I can, but I also am prepared to say that we have got to have dissent, we have got to have different opinions.... It's a check and balance, if you will, with the whole system.

Bringing the Two Sides Together

Although most of the interviewees noted that the interactions they had with industry had mostly been initiated by themselves, some felt that bringing about these interactions was still a major challenge. One researcher explained::

> The biggest challenge is fostering these interactions in the first place. . . . The big problem is the "matchmaking business." It is trying to get the two sides together . . . . Certainly, companies know a lot about what is going on in universities. We publish regularly. Drug-company publications tend to lag behind what they are doing by a few years because of their patent protection and other legal aspects . . . . So it's a little bit more difficult for universities to know what's currently going on in different companies.

Appropriate Reward Structures

One of the points that came up with regard to challenges facing university-industry links was the recognition and rewards to those university researchers involved in university-industry research. One academic administrator reported having observed from his experience over the years that researchers involved in industry research had not been appropriately recognized with regard to promotions or tenure in some faculties, stating:

> If someone comes along who has never had ... peer-review research support, there is concern expressed, because I think deep down there is still a feeling that we should do research that meets the test of peer review and not the test of a Vice President of Research in a company elsewhere.

Enhancing and Maintaining Research Excellence of the University

If there was any issue which the interviewees agreed was of vital importance with regard to industry links, it was the quality of research at the University. Most felt that it was because of this that industry was attracted to the university and thus there is need for the university to enhance and maintain the quality of its research programs. As one researcher put it:

> I think we have to aim at maintaining or elevating our prestige in science, and the companies will learn about our work and will want to fund it. I don't think we can make companies fund us in any ways other than pure science. So I don't know if the University has truly learned that yet. We just have to do the best we can to maintain the quality of research.

Another researcher was concerned about the repercussions of not maintaining research excellence as a result of recent budget cuts. He pointed out that faculty members might leave and go to more attractive places.

Marketing by the University

Thirteen respondents considered marketing as essential to fostering more links with industry. They expressed the view that the University should market itself more than it has done in the past. As one researcher put it: "I think that the major challenge is to make industry aware of the potential we have for research." Another researcher pointed out that:

> If the university takes success stories out, administrators to industry, and simply tells industry that the university is open for this sort of thing, that they are welcome, then when there will be a bit of a change in attitude, maybe they will try to come and look around.

However, while agreeing on the importance of marketing, a Senior University administrator cautioned:

> If we have no technologies to market, if we have no professors coming up with creative ideas, if we aren't able to keep our good professors, given the tough economic times, if we aren't able to compete and attract the very best people here, there is not going to be any competitive industrial work going on.

It is apparent that marketing alone is not sufficient. Marketing has to be tied to the quality of the researchers and the technologies and expertise that they have.

One of the suggeations made was that the University must find ways to attract funds from industry. A faculty administrator pointed out: "Our [role] is to keep industry interest up and investing in the University ... when we are being hit pretty hard with financial constraints." How should this be done? Another suggested that the University should "attract money here, that we make contacts ... that we present our best research to these industry representatives in a way that they will see the economic value to it and bring money to Alberta." Yet another added that "we should attract industry into supporting research on an ongoing basis ... and make it attractive to them to do so by reducing the overhead charges, for example."

Strategic Planning

The importance of planning for these collaborations was very much emphasized by some respondents. One researcher, while commenting on the inadequate resources available to the IPC office for it to play its role in university-industry activities, noted that "we need a very detailed strategic plan and step by step tactics to lead to the technology transfer process."

There was a feeling by some respondents that the government did not have a coordinated approach to university-industry links and that most government departments acted in isolation. One researcher explained: "These ministries don't talk to each other and they make policies that are counterproductive." Some respondents called for a coordinated approach to university-industry links between the government, university, and industry. One researcher explained how this might be done:

> The other major challenge is to have a coordinated approach involving government, industry and the university. I think that there is a need for a committee to look at policies that are established by government and determine whether their effects were encouraging or discouraging university-industry interactions. This would call for senior people from advanced education, technology and development, senior people from industry and people from the university to sit down and discuss how policies made in different areas have impacted on their ability to [take a coordinated approach].

In summary, the challenges facing these partnerships, as expressed by the respondents, emphasized the development of positive attitudes between the two sectors in order to eliminate some of the old negative perceptions of each other; the provision of appropriate reward structures for researchers involved in industry research; the need to enhance the quality of university research programs so as to attract industry funding; stepping up of marketing of its research programs by the University; and the need for strategic planning.

Insights into Partnerships

Based on the experiences with existing and past linkages the respondents described some of the lessons learned and insights gained from their involvement in these research partnerships. In this section, this insights are presented in two parts, first those that relate to the University, followed by those that relate to industry.

University Referenced Insights

Insights that relate to the University range from the quality of University programs, marketing, researcher to researcher interaction, and the growth of competition for industry funding to the facilitative role of other external agencies that fund university R & D programs. These insights are:

High quality research will sell. Ten respondents said that they had learned that, without good-quality research, industry would not come to them. This is related to one of the challenges noted earlier by one the respondents who noted that industry would only " fund us if we are doing good science" and would not "fund second-rate science" and thus the challenge to "do our very best to attain the level of excellence that companies would expect".

More marketing by the University. One of the items mentioned most frequently mentioned by respondents (14 respondents) was that the University did not market its research as it should. A number of times comparison was made to other

institutions that tended to market their research profile better. One researcher remarked: "We have to increase our profile. We need to market ourselves better." This insight was also considered a challenged as mentioned earlier in this section.

Importance of researcher to researcher relationships. Twelve respondents emphasized the importance of personal relationships between researchers in the research partnerships involving the two sectors and considered this as the *sine qua non* of the success of partnerships.

Competition for industry research funds and importance of preliminary research results. Two respondents reported that they had learned that many university researchers from other universities approached industry with research proposals for funding. Because of this, it was important to have some preliminary research results available before approaching industry to increase the chances of success. One researcher stated:

> If you are going to go to industry, you are very much better off to go to them with some results rather than ideas . . . . It is better if these ideas have some basis. If you want to get their attention, go with some preliminary results.

Valuable role of Alberta Heritage Foundation for Medical Research (AHFMR). The significant role played by AHFMR in assisting pharmaceutical and medical researchers with technology-transfer grants was acknowledged as one of the lessons. One researcher explained why the AHFMR grants were valuable, "AHFMR has been of great assistance in helping us with technology-transfer grants. These are small grants that help us to get these preliminary results, and so when we approached industry we were not starting from the very beginning."

In addition to insights gained that related to the University side, respondents also described the insights regarding their experiences with industry.

Industry Referenced Insights

Insights that relate to industry described by the interviewees fell into five main categories: the calibre of industry scientists with whom the University researchers

collaborated, the focus of industry's interest in the University, industry visits to campus, project champions within industry of partnership projects, and the philantrophic actions of some of the companies. These insights are:

Quality of scientists in industry. Some respondents noted that they had come to realize that industry has a high caliber of scientists, which was contrary to the past beliefs of university researchers. One researcher summed it up:

> We used to think that industry took the second-grade scientists .... In fact, through this difficult time of financing, many of the industry's scientists are first class, and they have more to offer top-notch people; thus they have excellent people in-house doing research, evaluating grants. So the idea that . . . industry-funded research is second rate isn't true any more. There is a lot of good research done by researchers supported by industry. . . . So the magnitude of research that is going on in industry is very good. And that was a surprise to me, the magnitude and the quality.

Another researcher even noted that industry was more advanced in some scientific and technological areas than the university and remarked, "I have learned that in some areas industry may be advanced and ahead of the university in terms of what they are doing."

Industry interest in universities in specific skills. Two researchers noted that industry was interested in universiities for speficic technical expertise. As one respondent put it: "companies are interested in us for specific skills and not for our generic skills."

Industry visits to campus have been positive. One faculty administrator noted that from the experience of bringing industry people to visit campus to see the caliber of researchers and facilities available, the results have been positive. This respondent noted that most of these industry visitors went away wondering why they had never thought of the University of Alberta for their collaborative research projects.

The importance of a project champion in industry. Five researchers underscored the important role of having a person in industry whom some described as "a project champion" who would be in constant dialogue with the researcher and would champion the course of the project within industry.

Some companies are altruistic. Although it is generally believed that industry will not fund research without expecting something in return, one faculty administrator noted that he had learned from his experience over the years that some industries were more altruistic. "I have also learned that some companies are a little bit altruistic in their approach. They are not all pushing product development."

The insights gained by researchers did not only have bearing on the University but on industry as well. That the quality of university research programs would sell, the vital role of marketing by the university, the significance of researcher to researcher interaction between the two sectors, and the valuable contribution of AHFMR were some of the insight highlighted relating to the University. As for those relating to industry, the recognition of the high calibre of industry scientists, the realization that industry sought university collaboration because of specific skills, the positive results of having industry personnel visit campus, and the important role of having a partnership project champion in industry were some of the significant insights described.

Summary

This chapter has discussed the basis for engaging in collaborative research and development activities from the perspective of those who have been involved in some way from the University sector. The initiative to establish these partnerships varied. In some cases the initiative came from the University researchers and in others it was from industry. The two were mutually attracted to one another based on their needs and the forces of attraction that drove them, be it knowledge, expertise, skills or inventions already made by the university researchers, to name only a few.

These partnership initiatives had to be formalized through research contract or grant agreements. Respondents reported they encountered a number of problems with these. They claimed that the time taken to finalize these agreements was unnecessarily long and discouraging, the negotiation part was not a pleasant one either, given the competing

demands on both parties. University researchers suggested that from their perspective the University administrative structures and especially the offices that handled the negotiations were rather rigid. This criticism included the lawyers' handling of these agreements. Complaints were made of the bureaucracy of University administration, the fact that it took too many people to make decisions. The extended approval process was seen to cause impatience and some elements of frustration. The role of University structures in these partnerships featured significantly, and especially with regard to their facilitative versus supportive or leading role. Positive features of the structures were also mentioned. Reference was also made of the effect of the academic reward structures on university-industry research collaboration -- that there was little recognition of university industry research in terms of promotion and this was considered by some to be a disincentive for professors to become involved.

These University respondents appreciated the current policies or programs meant to encourage university-industry partnerships although they felt that more needed to be done in this area, especially in the current climate of budget cuts. Special praise was made for the following government programs: the federal NRC's IRAP, NSERC, and MRC programs, and the provincial AHFMR university-industry programs. The environment with regard to how conducive it was for the initiation and the operation of these partnerships was considered favourable and yet wanting in certain respects. The environment, they noted, had definitely improved for the better over the years. It was more open and more accepting of university-industry collaboration and this was especially so within the University. However, there was still an aura of suspicion of each other's intentions between the two sectors. Even within the academy, there was still a remnant of resistance about research involvement with industry and an aura of distrust of those who engaged in these collaborative activities. In addition, mention was made that at times there was "tension between the academic entrepreneurs and central administration" with regard to matters such as the use of overhead funds. The fact that Canadian companies had a weak

research culture did not augur well for university-industry collaboration in this country and this was evident in the greater number of foreign companies that have links with the University. Further, it was noted that some in industry still questioned their investments in these partnerships. Yet, despite this, there was evidence of increased collaborative research and development activities.

The importance of one-to-one relationships based on trust and respect between university researchers and researcher in industry was emphasized as crucial to the success of each partnership. The role of university administration in these partnerships was at times questioned; respondents claimed that university administration should play a secondary and supportive role. That those who are involved in the partnership activities should keep in constant touch was considered essential for the success of these activities. Maintaining and elevating the research excellence of the University was emphasized as critical to these partnerships because it was the quality of the research that had attracted industry to the University in the first place. There was recognition by some of the strategic importance of having a "champion" of the project in industry to ensure the monitoring, the maintenance and sustenance of the relationship and especially the actual transfer of knowledge and technology from the University to industry, and seeing to its subsequent application in the industrial setting. Similarly, respondents acknowledged the importance of marketing by the University of its research activities and potentials. Within the academy, there was, however, some ambivalence as to who should do the marketing, the liaison office or the researchers themselves.

In conclusion, there was a sense of optimism by the respondents that the future can be better for both the University and industry if they overcame the challenges identified and obtained the needed resources and the optimal environment for these activities to grow and prosper.

CHAPTER 6

PERSPECTIVES FROM INDUSTRY

This chapter provides the views and experiences of 12 industry administrators and researchers on a number of areas in university-industry collaboration on research and development. These include the reasons for their participation and the logistics, structures of collaboration, policies, environment of the partnerships, benefits, problems, challenges and lessons derived from these experiences. Five of the of the 12 respondents were primarily administrators while seven of them were both administrators and researchers in that although they were involved in some aspects of administration such as heading research sections or research divisions, there were involved in actual research work as well.

Initiation of Partnerships

Reasons for Research Partnerships

Respondents provided reasons why they became involved in research partnerships with the University. The reasons included attraction to the highly specialized expertise at the University, inventions already made on campus, the fundamental research environment, facilities and equipment, and the cost factors. These are elaborated in the following paragraphs:

University expertise and commercial exploitation of its technology. All industry respondents reported that they were attracted by the expertise available at the University, expertise that they did not have in their companies. As one industry administrator put it: "There are people there who have specific knowledge and experience, particularly in technical areas. It is more specialized, and it is usually the leading-edge knowledge that we are looking for." The president of a small-size company added:

> You are close to the expertise; you know what is going on at the university; you know the technology that is being developed. . . . So, you can

> actually take a chance and pick up some of these technologies for commercial exploitation.

Attraction of university inventions. Some of the respondents reported that were attracted by some of the inventions that had already been discovered by the professors. In some of these cases, the professors approached industry to find out if they were interested in sponsoring the patenting and further development. This is how one industry executive explained it:

> In one case the attraction to the University was that the professor came to us and said, "Look, I have discovered this thing. I think it is of interest to you because I know you do this sort of work. Would you be interested in, first of all, sponsoring the patenting and, second, sponsoring some more development?" After studying the thing, yes, we found it was attractive, and we went on and did this. . . . It needed some work, and we were attracted by the science, by the technology, by the invention.

Thus it is not only the university researchers invention but the probability of successful further development of an invention having good potential that attracted industry to collaborate.

Fundamental research at the university. Five respondents reported that they were motivated to collaborate with the university because of the fundamental research which they themselves were unable to do or did not have the time to pursue but yet considered important for their business development and goals. One company's team-research leader the motivation behind their involvement with the University:

> Our philosophy as a company is that we feel universities do have a role in technology invention and fundamental knowledge development. We at this point still distinguish a university engaging in more fundamental science in a far better way than probably ... we are positioned to do at present. We will conduct research and develop an understanding where we feel it is useful to do so, but it is carried with a business objective in mind. So many things we'll look at and say, "This is an interesting piece of science that we could work on, but ... we do not have the time and luxury to spend on it. That is where we tend to see if there's a university interested to maybe foresee some of those things. So we see the university as complementing the work that we do. There is a middle ground of overlap that is healthy and that allows for collaboration.

Whereas in the preceding example the university researcher ("the professor") had taken the initiative to contact industry, in this example it was industry that took the initiative

to search for fundamental research at the University that seemed to have the potential to enhance their business.

Knowledge transfer from the university. Noting that they were in business and faced with competition some respondents reported that they sought research collaboration with universities in the hope that it would help them to be competitive. This is how one respondent put it:

> In the marketplace we are a smaller company, so we need to find creative ways to leverage our efforts that will allow us to compete effectively with corporations such as Dow and Exxon of the United States. These companies have tens of thousands of employees, their research is almost 10 times the size of ours, and if we want to compete effectively with these people, then we need to ... leverage as much as we can. And one of the opportunities that exists in Canada is to seek the assistance of the university. So when you have experts such as Drs. _____ and _____ at the University of Alberta and others from Waterloo, these people have great value to us in terms of being able to work some of the likes and wants, and the benefit is obviously that we get better understanding coming back into the company, and that is where we want that knowledge transfer to occur.

Access to facilities and equipment. In addition to the above-mentioned factors, the availability of specialized equipment and facilities at the University was cited by some respondents as one of the the reasons for their companies' collaboration with the University. In some cases specialized equipment that the companies could not afford was available at the University.

Cost factor. The fact that that accessing university research through contracts was cheaper than hiring professional consultants was identified as one of the motivating factors for collaboration with the university. One industry research manager noted: "You tend to get more value from university research than if you went to a consultant, where you would be paying full professional rates." Another added: "If we can get something at reasonable cost at a university, then it becomes a logical thing to do. So I guess we are partly ...constrained by our lack of resources." The motivation in this case seems to have been the ability to undertake research they would otherwise not be able to afford, namely, a cost factor, other considerations notwithstanding.

Policy Framework

This section provides the perspectives of industry respondents on the policy environment in which the partnerships they were involved in operate. First, the respondents' general assessment of the environment is provided. This is followed by their perspectives on specific university and government policies as they affect these relationships.

The Nature of the Environment

Interviewees were asked to assess the environment in which they participated with regard to quality of the partnerships. Their comments on the environment of the partnerships ranged from "excellent" to "not conducive." Such terms as "good," "improving," "conducive," "better," and "creative" were most commonly used. Most of these industry interviewees agreed that the environment was good and had improved compared to what it had been in the past. As one Vice-President for Research in a company put it:

> The environment is conducive for linkages. The roadblocks are much less than they used to be, and you are getting chair people in the departments now and deans that have strong industry contacts, and that can only help the environment.

Some, however, noted that the environment was made difficult by government cutbacks. For others, although the environment was perceived to be favourable, it was being hampered by the lack of adequate finances for these partnerships. One researcher stated: "For my own case, the environment is good. The creative environment in terms of research is excellent. This is, however, hampered by limited finances." On the other hand, some others felt that, because the financial pressures made the two sectors search for collaboration with one another, these financial pressures provided a positive stimulus. An industry administrator commented that these pressures resulted in "a bit of change of

attitude" and forced the two sectors to seek partnerships:

> I think without this pressure, a lot of what is happening now would not have happened. I think the University has a little absence of reality in its thinking. It somehow believes that money will just flow in; but it will not. That is slowly sinking in, but it is slow.

One research manager noted that university researchers were cooperative but this individual found the Office of Intellectual Property to be wanting:

> The faculty, the professors that we contact are very willing. They want to work with us, and we want to work with them. We find the offices such as the Intellectual Property Office tend to be a concern for both parties, and that's been our experience. We have always found that when we are looking to talk to faculty members they have always been very keen. Our problem is that we have so many requests that we have to deny many of them. We only have a limited pot of money to fund these collaborative research projects. One of our problems is to determine how to distribute that most effectively, because we do have more requests than we can possibly fund.

The environment is, therefore, constrained by limited resources that companies have for these projects. Further, a few respondents felt that there were still some "elements of distrust, but not as prevalent as it used to be." One administrator went on further to describe the environment

> as one in which a great deal of suspicion exists as to the other's motives; one with a great deal of unfulfilled opportunity; having very talented people in both sectors and being ripe and ready for collaboration, with a great deal of uncertainty as to how to go about it.

Three respondents in small companies felt that the environment was not conducive for them because the university faculty looked for bigger projects and hence better financial offers that were available from large companies. An executive of a small company stated: "I think the environment is not very conducive because the faculty is looking for big projects and most small companies have small projects in terms of budgeting." Small companies, therefore, felt neglected and overlooked by both the university and the government.

University Policies

Seven respondents lauded the policies of the University of Alberta regarding links with industry. They found them "acceptable," "reasonable," and "flexible." Positive mention was often made of the patent and the intellectual property and royalty policies. One respondent, for instance, stated: "There are not too many restrictions. That is one of the advantages at the University of Alberta at present. I hope they will not change." Another respondent, while referring to the delay period allowed for patenting of the intellectual property before publication of the research results, praised the publication policies of the University, saying, "The University seems to have taken a better stance towards understanding the needs of industry." Thus, in summary, most of the comments on University policies on university-industry partnerships were positive.

The were a few areas of University policy, however, that did not receive positive comments. One of these was the policy on overhead costs. Most industry respondents did not like the policy on overhead charges, referring specifically to the 40% overhead costs on contracts. Here is how one respondent put it:

> I think having a set percentage as an overhead, I don't know if that is appropriate because situations vary. The company might even in some cases be required to put in more than the investment or be more responsible for moving the project. In other cases the professor will be doing the majority of the work, and the university will have an involvement. So having a set percentage of 40% of any dollar going to a professor I am not comfortable with. I think it should be determined on a case-by-case basis, negotiated maybe within a certain range.

The charging of overhead costs is, therefore, appears to be as much an issue for industry respondents as it was for some of the university respondents as noted in Chapter 5.

Apart from the overheads, the other complaint raised regarding university policy was the presence of spin-off companies or companies on campus and the provision of facilities on campus for their use. For example, one respondent stated, "Some of the companies have existed on campus for many years, and any [outside] company has a

legitimate authority to be concerned about that. They may be exploiting or using this position for their advantage," referring for instance to use of university technicians funded from public funds.

With the exception of the above criticisms voiced, most of the industry respondents interviewed liked the University policies.

Government Policies

Respondents made reference to the programs that the government had initiated from which they had benefited, whereas others said that they had not taken advantage of them though they were aware of their existence. Seven respondents cited the federal government programs that they considered to encourage university industry collaboration. Some noted that the federal government had done more in encouraging university-industry collaboration than had the provincial government:

> To put it quite bluntly, the provincial government does not really understand the issues. I think I know enough of the people and have talked to enough of them that I am satisfied they don't understand the issues. They set up the institutes, but they don't fully understand the role that they are playing or that they should play. My experience is that with the federal government programs, there is more thought and what-not going into some of the programs.

There was concern expressed again that government policies did not support small companies but were more beneficial to large companies:

> The government policy is very good in principle but it only helps the bigger companies and not the small companies. The Alberta Research Council (ARC), for example, prefers the big money players first, and not many Alberta companies have taken advantage of ARC because of this fact. So unless the government or the university has some clear policy that they have to help Alberta companies or there is some sort of government requirement that they will have to help Alberta companies, I don't think the university will have any priority for the Alberta companies ever.

Another criticism of government policy was with regard to the governments' messages that "that universities have to become more practically oriented in their research" and that such calls "may frighten away some of the best researchers that we have." While

agreeing that universities should be involved in applied research, these industry respondents emphasized that fundamental research was extremely important in universities.

The following government programs, each of which was discussed in Chapter 4, were mentioned quite frequently as having contributed to enhancement of university-industry collaboration in research and development.

Industrial Research Assistance Program (IRAP). Some respondents who were aware of the existence of the IRAP program operated by the National Research Council (NRC) rated it very highly. One respondent's remarks perhaps summarized the sentiments of the rest:

> I think if any federal government program was to be isolated and praised, it has to be the NRC's IRAP program. That program is fabulous. It is probably the best in the world in terms of assisting industrial development and university-industry collaboration.

The Medical Research Council (MRC) Programs. The MRC programs on university-industry collaboration were cited as good programs that fostered university-industry collaboration in the medical and pharmaceutical fields.

The Alberta Heritage Foundation for Medical Research (AHFMR) Programs. The AHFMR program was also recognized by industry respondents as having contributed to collaboration in the biomedical field.

Natural Sciences and Engineering Research Council of Canada (NSERC) programs. Respondents commended NSERC's programs, which matched any funding by companies of university-industry collaborative research. Most of the university-industry R & D projects at the University benefited from this program.

Investment Tax Credit Program. This federal-government policy whereby companies were offered tax credits for money spent on research was hailed as a good policy. Some companies reported that they had benefited from this policy.

Organizational Structures

In this section, perspectives of industry respondents on the institutional organizational structures for these research partnerships are described. First, their perspectives on industry structures are given. This is followed by their assessment of the University structures.

Industry Based Structures

Companies which participated in the study did not have any specific established structures for collaboration with universities. Some had research and development departments, vice-presidents in charge of research and directors or managers in charge of research programs. Any matters of collaboration with the universities would be handled by some officer within the research and development department or the relevant program in which the collaborative research activity was involved. In some companies, and especially in small ones, most of the liaison activities were handled by the president of the company. This was especially so from the negotiation stages to the signing of the contract.

Some companies had research *management teams* in a specific area of research, and such a team would handle issues pertaining to the university. Two companies were reassessing their organizational approach to the universities, given that their collaboration with universities had increased. For instance, one respondent stated:

> We are working as a management team for our ____research (field area of research) to put together an integrated approach to working with universities and external funding, and that includes institutions outside of the university umbrella such as the National Research Council and the Alberta Research Council. As we are growing we are now getting to the point where we realize we have got initiatives that have been started in a number of universities, and it has gotten to the point where the program overall has grown to a size where we have to look at it as a totality. So we now have to look at the management of it and address the strategy of how we actually support various programs. We are establishing, I think, a much more organized approach to how we develop programs with universities.

Some companies were, therefore, giving serious thought to the structural aspects and strategic approaches to dealing with universities with regard to collaborative research.

University Structures

Most of the comments on structures by industry respondents tended to focus more on the university structures than on their own structures. Their comments ranged from negative to positive criticisms of University structures.

University bureaucracy. Eight respondents cited bureaucratic red tape as one of the main problems they had encountered in their collaborative activities with the universities. Some felt that the university structure was not well suited for collaboration with industry. This is how one respondent with working experience in both sectors explained it:

> The university structure is really inhibiting in many ways. First, the decision-making process is extremely diffused, very slow, very bureaucratic, and so what that means is that collaboration occurs as a result of more individual effort than because of university facilitation. The university structure as it is almost guarantees that there is no direction for the university. It guarantees that everybody is going in a different direction. Business would never operate that way.

University reward structures. It was noted by some of the respondents that the *academic reward structures* did not encourage commercialization but instead favored publication of research results. Commenting on this, one of the administrators stated:

> The motivation of an academic at the university is not necessarily to commercialize anything. It is simply to go and explore knowledge and commercialize in a small number of cases if it happens at all,... the motivation of an academic is not entrepreneurial in so many cases.... What is needed is a mechanism that will deal with that, and up to this time the university has not had a lot of good ones.

Another industry administrator expanded on the effects of the university reward structure:

> Universities are not structured in a way that encourages these academics to get involved in industrial liaisons of any kind. They have a reward system that rewards, by and large, the generation of papers. Those papers are funded largely by NSERC, and it's kind of a vicious circle: The more papers they write, the more money they get from NSERC, and they build up a machine that perpetuates that. That is not the fault of the academic; if it is a fault, that structure is in place, and so they work within that structure, and that is fine, but it doesn't do the industrial community any good. It doesn't encourage academics to get out and get involved with the industrial community and, until that happens, there ha[illegible]t to be a change in the structure.

It would seem, from the above comments, that, whereas offices of technology transfer have been established at the university to facilitate linkages with industry, the issues of reward structures which impinge on the researchers who participate in collaborative research appear to have been overlooked.

University offices of technology transfer. One industry administrator, although acknowledging the important liaison role that the offices of technology transfer at the universities plays in university-industry collaboration, noted that these offices need to focus more on what industry wants rather than on what they can provide to industry:

> There is greater need for them. That is okay; that is a fair motivation. What I fear is that the University stops at that point and forgets that they are trying to serve a marketplace and that they need to understand the market, because what they are trying to sell is a product they have, rather than looking at the market to figure out what product the market wants.

The offices of technology transfer, in marketing the ideas of university researchers, seem do so with good intentions. If there is any shift toward focusing on what the market wants, who should do this; should the onus be on the administrators or the researchers? The implications of the above criticisms of offices of technology transfer are that they should scan the market and provide feedback to the researchers who can then respond appropriately.

Thus, all the companies that participated in the study did not have structures designed specifically for university-industry partnerships, and two respondents stated their companies were beginning to give this idea some serious consideration. Regarding university structures, however, while acknowledging that these structures performed an important function, university bureaucracy and the lack of university reward structures for university researchers involved in these partnerships, were identified as obstacles that needed to be addressed.

Benefits of Collaboration

Respondents described how their companies benefited from participation in the research partnerships. There were four main types of benefits: the transfer of technology to the participating companies, the university providing sources of employment for the companies by training of students and especially graduate students involved in these research partnerships, increasing company efficiency and productivity, and enhancing university programs relevant to these companies. These are explained in the following paragraphs.

Transfer of Technology

Some of the respondents reported that they had benefited from the university researchers who through their expertise helped these companies develop their own company research expertise. One of these respondents explained:

> We do have expertise developed which is in line with the type of fundamental issues that we come across. The knowledge that is gained can then be transferred into our company, and we can build on that knowledge, so it helps to educate us.

Personnel Recruitment

Because most of the funding for collaborative research goes into funding and training of graduate students, some respondents reported that they had benefited by hiring graduate students who had been involved in the collaborative research programs between the university and their company. The following comment illustrates the point:

> When you tend to support and fund these operations, you are educating graduate students in the area, and these people can be a subsequent source of potential employees for us, ... and so it's developing a resource which can be of use to the company in the future.... we have demonstrated that capability, that we now have people working for [name of company] that have been part of the program, and we have subsequently hired them into the company and benefited from that.

Improving Industry Effectiveness and Efficiency

One respondent noted that "a lot of results of the research that we have undertaken jointly with the University has led to improvements in the quality of the projects, work or business that we do." Another respondent noted that the outcome of research collaboration has "saved us millions of dollars per year." It was noted earlier, for instance, that accessing university expertise was cheaper than hiring professional consultants.

Strengthening University Programs

One company reported that when the collaboration started about nine years ago, the university did not have a strong program in the area of interest to the company. However, through this collaboration,

> the University has established expertise and brought in additional faculty oriented in the polymers area. We have benefited in the programs that they have done and the type of research they have been working on, which was obviously related to our business interests.

In brief then, the transfer of technology from the University to the companies, the development of company research expertise as a result of the research partnerships, the resultant efficiency and effectiveness in the companies' products and operations, the development of university programs relevant to some of companies' field of operation, and the provision of well trained graduates as employees for these companies, have been the main positive outcomes of these collaborations.

Problems with Partnerships

Respondents described the problems they faced from the initiation stages of these partnerships to their implementation. These are presented in this section. Some of the problems emanated from the university, others from industry. Problems specific to small companies are also provided. Respondents' comments on these problems tended to focus

more on problems they encountered in the university sector rather than those in their own industrial institutions or environments.

University Bureaucracy

Similar to what has been expressed earlier in this Chapter,some industry respondents noted that their initial research agreements took a long time to finalize due to the "red tape" of university administration. They noted, however, that subsequent contracts took a shorter time as long as they were modeled after the earlier ones.

Overhead Costs

Nine respondents expressed dissatisfaction with the overheads which the University charged. Some noted that these costs were increasing, and others noted that there appeared to be no specific formulas for charging these costs. Still others felt that they should be flexible rather than a fixed percentage.

Attitudinal

Eight respondents felt that the negative attitude towards industry still existed within universities. One admiistrator illustrated this point:

> The negative attitude to industry is still there. We will get unsolicited proposals that don't focus on our problems or on the problems that we want to solve and we have on certain occasions tried to get involvement from some university researchers but they declined to participate.

Another provided a different example:

> We sometimes find the university not very sensitive to our needs. They often do not understand that we need the best quality to compete. . . . When you talk to a professor about wanting the best employees, the reaction you normally get is, "He is really not the best in academic areas but is good for industry. I would not recommend him as assistant professor, but he is good for industry."

Five of these industry interviewees reported, however, that over the years the negative perceptions had dissipated and university personnel were not as hostile as some had experienced in the past. One respondent recalled the reaction he received some years back when he tried to seek assistance from a university researcher for an industry problem

that his company had. He reported that the professor had told him to "go and read in the library" to find the solution to his problem.! Fortunately, however, another professor in the same department was willing to assist, and from then on that initial relationship has grown from a small project into more collaborative research projects between the professor and the company.

Negative attitudes were not confined to the university sector alone. Corresponding negative stereotypes of the university existed in industry as well. As has been noted, although some of respondents from industry reported the perceived negative attitude of universities toward industry, two respondents who were involved in liaison roles in industry noted that in their capacity as liaison officers or project officers for industry, they had a difficult time trying to convince their industry colleagues of the merits of having and maintaining links with universities and hence continuing fund collaborative research. One administrator/researcher said that those in the company involved with the universities had a hard time "keeping the people in the company interested in what we are doing so that the same level of trust [that he had with university researchers] exists. That is the problem we have to deal with." This problem seemed to be especially acute with respect to budget allocations to support university research.

Unrealistic Expectations of University Professors

Some industry respondents reported that university researchers held expectations that were too high in respect of patents that might arise from their research; they were apparently unrealistic about how difficult it is to protect the technology, and about how long it takes to develop a product from the patent stage. As one administrator put it:

> I think that there has been a tendency to overvalue the intellectual property that they may have and to believe that it is worth a huge fortune when it is in very rudimentary stages, and that therefore you should demand a very high price for it, and most times that is not realistic.

Time-Factor Problems

One of the problems reported by industry respondents was "finding time to follow these things," implying that once a contract had been signed, because of too other many commitments by industry personnel, the contract was almost forgotten as no one made a follow-up of any progress made toward implementation. At a later stage somebody would remember and follow-up would begin. Related to the time-factor problem are the consequences of "little interaction" between the company and the researcher and keeping track of progress. This is how one administrator explained it:

> Other times it has been lack of good tracking of the expenditures, in the budgets, knowing where we are. . . . How much have we spent? What have we accomplished? Give us a progress report. It is a question of keeping us up to date as to where we are. . . . We don't know where we are because we never hear from him unless we actually go and rattle his cage.

The tracking factor was compounded if the university was far away. Thus one respondent noted that his company had no problem with the University of Alberta in terms of communication, given its nearness to the company. Related to the above, as one industry administrator put it, "in some cases the time the university takes is longer than industry can allow"; or, as another respondent noted, "longer than we would normally anticipate."

Programs Drifting away from Their Original Intent

Some respondents noted that sometimes the university researcher did not stick to objectives specified in the agreement thus causing research programs to "drift away" from the original intent. The resultant effect is that the problem for which the company sought the university research assistance and hence the agreement is not addressed. One respondent explained that this drift could be the result of not keeping constant track of the program and not communicating regularly with the researcher.

Utilizing Fully the Knowledge Transferred from the University to the Company

Three respondents noted that after a contract was signed and a report turned in at the completion of the research, that seemed to be the end, and not much further was done by the researcher to assist in the implementation or the application of the findings. One industry administrator elaborated:

> We feel that many times before we've initiated programs with universities, and you send money and they would do the work and then they would publish a paper, and that would be it. The contribution back to the business was difficult to recognize. . . . I think the problem we really had is being able to harness the knowledge gained and transfer it into the company, and that's why I mentioned earlier that . . . one of our criteria is to have a main contact who actually commits some of their time to the program, to following the programs and interacting with the faculty members. That is ... we hope to address the knowledge-transfer issue so that we don't just send money and wait for a report to come back in two years. We want to have an ongoing dialogue: we want to have collaboration.

Feeling of Neglect by Small Companies

One administrator from a small company reported that "to attract the attention of the university staff is the biggest problem. For a small company to get the attention of a university professor is difficult." This respondent felt that contract research that had been done for his company was done because he personally knew the professors, and he doubted whether they would have done the job otherwise. In his words, "I think they sort of think they are obliging you because you are too small, and your project is small. 'But ... because we happen to know you, we will do it'."

In summary, partnership problems experienced by industry respondents were: university bureaucracy, charging of overhead costs, negative attitudes of some university researchers that still existed towards industry, unrealistic expectations by university professors of the value of their patents, lack of regular communication and hence follow-up of some of collaborative research programs, and the small companies feeling neglected by university researchers in search of higher funded projects of large companies.

Challenges to Partnerships

Research and development partnerships pose certain challenges that potential participants and those already involved need to address or overcome in order to benefit from them. Interestingly, most of the respondents from industry focused more on what universities should do to overcome the obstacles to the partnerships rather than on what they in industries should do. Their perspectives covered such areas as attitudes, marketing, the nature of the research links, cooperation, university educational programs, companies' commitment, competition faced by small companies and problems of dealing with university liaison offices. These are elaborated as follows:

Fostering Positive Attitudes Between the Two Sectors

It was noted earlier that in both sectors negative attitudes towards each other still exist. Most respondents called for an end to this. One administrator, with reference to the universities:

> I think the challenge is to open up and not consider industry as a fat cow that, first, can afford everything, because it can't; and second, that they are out to gouge you and all that kind of thing, which is nonsense. Most professors, by the way, don't think that way. There are the occasional few that do, and they are quite loud.

The challenge then, as one respondent put it, would seem to be to "understand and appreciate each other's culture."

Marketing by Both Sectors

The need for both sectors to market their potentials and what they can do for each other was very much emphasized. One administrator explained: "The University doesn't sell itself very well.... Industry doesn't sell itself very well in terms of either what it can do for the institution or what it needs from the institution."

Another administrator emphasized the need for the University to market its

inventions well:

> The University here [U of A.] has particularly had an incredible amount of new inventions. These have to be taken and shown to the world in case somebody needs one. It is being addressed now. Again, I say that the Intellectual Property and Contracts Office is moving in the right direction in this respect. But that has certainly been a challenge.

Extending University-Industry Links to Educational Areas

Another comment related to the marketing of university inventions is that the university should respond to market demands. One example given was the education and training of company staff. As one administrator put it:

> The universities need to understand that there is another market opening up there and they have an opportunity to play a role in it. . . . So university and industry collaboration is going to have to happen in educational areas as well as research.

Being Productive Together

It was noted that it is not enough for the two sectors to seek each other for whatever benefits they expect to obtain; they should focus more on how the two can work collaboratively together. As an industry administrator indicated, "It is not just the question of universities reaching out and finding more dollars from industry to finance what was previously financed by somebody else.... It is being productive together that is the challenge and having to recognize it."

University's Ability to Keep up Demand by Industry

One industry executive, noted that the challenge of university-industry links lay in the universities' ability to meet the expected rising demands for these partnerships by industry, stating: "Can the universities keep up with the demand by industry in terms of development of technology? I think that is the biggest challenge."

Entrepreneurial Training in Universities

An industry administrator noted that universities are weak in entrepreneurial skills, technology transfer, technology management, product commercialization, and product

development. These areas need to be strengthened. The same respondent emphasized that, "Without these skills we will not have effective relationships between these institutions because it takes these kinds of skills to make them happen and make them workable."

Allocation of Limited Resources by Companies

Some respondents felt that allocation of limited time and resources by companies for university-industry research projects was a challenge given the different competing needs for funds in industry.

Interpreting the Results of Research in Terms that Industry Can Understand

One respondent stated: "Sometimes the university folks don't recognize that they have got to interpret the results in terms that people can understand readily." This respondent reported a case where he had invited a university professor to talk to senior vice-presidents of a company on "a very out-front subject," but the presentation was too advanced for the industry personnel present and appeared too theoretical and so they were not impressed.

Competition for University Expertise Faced by Small Companies

Competing for world-class researchers at the University with big companies was considered a challenge by a number of small companies. This is how one administrator explained it:

> I think it is difficult to tie in with world-class or quality professors who haven't been associated in some way with another company. . . . Major players are starting to realize the importance of tying in with universities, so people with world-class reputations are very quickly scooped up, so to speak, by other companies. So ... a major challenge for us, is to identify an expert in an area and come to some kind of agreement before somebody else does.

Dealing with Licensing Departments of the Universities

Dealing with the intellectual property offices at universities was identified by some of the respondents as one of the problems faced in these collaborations. This is how one

industry administrator explained: "The challenge is always dealing with licensing departments from universities, mainly because I don't think they have an understanding of the science involved and the investment involved." It should be noted here that this challenge was also identified earlier in this Chapter as on of the problems facing those involved in research and development partnerships with the University.

Insights into Partnerships

Based on their participation in and experiences with these research links, respondents described the lessons and insights that they had obtained from this involvement. These lessons ranged from greater understanding of their own companies to insights into the university sector and what both need to do to make these collaborations better.

Human Factors

In this section insights relating to human activities are presented.

Industry project champion. The importance of having somebody within the company who would monitor and support the university-industry research project was cited as one of the insights derived from these collaborations. One industry administrator expressed his feelings about this need: "We have to allocate somebody who is a champion on that project and is in constant touch and has to have time allowed to do this.... That is the main thing I have learnt." Another administrator/researcher added:

> So now in all programs that we are trying to develop with universities we have a scientist or an engineer identified as our main contact for that program, and they have a commitment, they express a commitment ... to that program and that they will be working with the various faculty members at the university in support of the efforts so that we get a net transfer of expertise and knowledge that is developed at the university back into the company.

Regular communication and dialogue. For a collaborative project to be successful, "we have got to be constantly in touch and constantly on top of the situation." As was noted earlier, problems of delay in submitting results as well as programs drifting from their original intent were attributed to failing to keep in touch with the researchers

Development of a one-on-one relationship based on trust. Seven respondents noted that the development of a one-on-one relationship between a university researcher and an industry person based on trust is essential to building bigger and better partnerships. This was therefore considered an essential element in the development of partnerships between the university and industry. One administrator summarized it as follows: "If one-on-one relationships between individuals on either side can be developed based on trust and respect, that will grow into bigger and better partnerships."

Patience. To build an effective relationship in the partnership, "patience and understanding of what the university requirements are" appear essential.

Working on common grounds. The importance of working on common goals and values was emphasized as essential to the success of partnerships. As one administrator put it:

> If we can work from a foundation of common values, common beliefs, common aspirations, and try to bring them together to achieve much shorter term goals and work together to identify mutual goals in the shorter term, then that way we have a chance of enhancing the relationships and making them better.

Managing jealousies. It was noted by a few respondents that professional jealousies were bound to develop outside the partnership, and these need to be managed. This is especially so in cases where those involved with industry research benefit financially.

Personnel exchange between the two sectors. Some of those who had participated in programs at the university underscored the importance of personnel exchange. One of these explained:

> We have got to get more interchange of people between the two. If we can get more industry people involved on campus as guest lecturers, as sessional lecturers, as whatever, then that has a terrific advantage, because suddenly they'll become aware, much more aware of what's here, and they will begin to understand the system a little bit, so they will know how to try to work with it. Similarly, if we can get the university people out into industry more, and that requires effort on their part to actually get out and find companies and not wait for the companies to come to them, but rather go looking for places that maybe could use their skills and expertise, then they would likely become much more market oriented.

Partnership Potential

Some industry respondents noted that, from their experience, they had learnt of the untapped expertise within universities that needed to be explored and exploited. However, the challenge was how to benefit from these unexplored talents. One industry administrator elaborated:

> I believe, buried in the universities to the extreme, there is tremendous talent, there is tremendous capability to enhance our society; and the industrial sector isn't quite sure and doesn't quite know or isn't quite prepared to take the time to change itself to get that talent out and make it happen. And on the university side, I think that there are similar feelings too.

Need for Planning

In working out these collaborative research projects, the importance of planning was emphasized. This is how one administrator explained it:

> The perception that the university takes longer than industrial research has been there for a long time and I think it still goes on. But that need not necessarily be an impediment, as long as we follow the project carefully. And that programs are drawn up and clearly indicated up front as to what is planned. Research is a fickle thing, you know; you don't know what the result is, so you can't predict what's going to happen. But you can have a plan as to, if it works you do this; if it doesn't work you do that. So there are a lot of what-ifs, and these things can be put together. It gives a lot more discipline.

Appreciation of Role of Partners

Some of the respondents reported that they had come to appreciate the importance of collaborating with the universities and to appreciate the differences between industry and

the universities as institutions. This is how one administrator/researcher put it:

> I think the lesson is that collaboration is important, for us to keep the dialogue going between universities; ... without it the benefits for both parties may not be as good; ... we have to, as a company, understand the university environment....You have to be reminded that it is a creative environment, and it doesn't necessarily work on deadlines. But if we collaborate with universities, I think we can solve a lot of problems in terms of keeping the programs moving in directions ... suitable for both parties, and so be able to bring that knowledge transfer in. I think that is just the key, which is why we as a company, as a management team, have said that collaboration is important.

Thus regarding the insights gained by industry respondents, their recognition of the importance of appointing a project champion within industry, the appreciation of these partnerships, the significance of constant communication between the two sectors and development of researcher to researcher interaction, patience, the contribution personnel exchanges between the two sectors as well the need for planning for these research links were the major ones emphasized.

Summary

In this chapter, an assessment of collaborative university-industry research and development activities from the perspective of those who have been involved within the industry sector has been provided. As was noted in the preceding chapter, the initiative to establish these partnerships was undertaken in some cases by the university researchers and in others by industry. The two were mutually attracted to one another based on their needs and expectations of the partnership meeting these needs. Quite revealing was the high value that some in industry attached to fundamental or basic research at the university.

Respondents from industry, as was the case for those from the university, reported they encountered a number of problems such as that the time taken to negotiate and finalize these agreements was unnecessarily long and discouraging; that the university administrative structures for these partnerships were bureaucratic and especially that the offices that handled the negotiations were rigid; that it took too many people to make

decisions; and that academic reward structures did not encourage university-industry research collaboration; and that overhead costs were a problem.

Similarly, the respondents lauded the current policies or programs meant to encourage university-industry partnerships. As was true for their university partners, they recognized and acknowledged the vital role played by the following government programs: the federal NRC's IRAP, NSERC and MRC programs and the provincial AHFMR university-industry program. Some considered the environment for university-industry partnerships as favourable while others felt that it was not as good as it should be. Like the University respondents, they agreed that compared earlier times the environment had improved for the better although suspicions and distrust still existed between the two sectors. Despite this, however, respondents noted that there was increasing interest to collaborate within both sectors. Some companies, for instance, reported that applications or requests for funding to undertake industry-related research from university researchers exceeded what they could afford to fund from their limited and dwindling budgets. The concern by small companies who felt they were neglected because they were unable to compete for university resources with large companies was also expressed.

Like the university respondents, these interviewees supported the importance of one-to-one relationships or researcher-to-researcher interaction based trust and respect, as well as maintaining constant communication between those involved in collaborative R & D projects as crucial to the success of these partnerships. The importance of planning as well as the strategic role played by an industry "project champion" to ensure that the objectives of the partnership are attained was emphasized by some of the respondents. A call was also made for marketing by the university so that industry could know what the university had to offer them in areas of research and development.

CHAPTER 7

CASE STUDIES: THE UNIVERSITY OF ALBERTA-SYNPHAR AFFILIATION AGREEMENT AND THE TR LABS CONSORTIUM

Introduction

In this chapter, two case studies of university-industry partnerships are presented. The first case is an affiliation agreement between the University and a locally based pharmaceutical company. The second case is a consortium in which the University is a member and one of the original initiators of the consortium. The consortium's head office is in Edmonton, but it has branches in four other cities in western Canada.

The two cases were selected for the following reasons: (a) they are locally based; (b) both involved several participants from each of the two parties, the University and the company; that is, more than one researcher from both parties were involved in the partnerships; (c) the nature of the agreement for these partnerships allows for inclusion of more participants and was, therefore, not restricted to individual researchers; (d) the two partnerships explicitly included students in their agreements (such as sponsorships) and their participation in the research activities was stipulated; (e) the partnerships went beyond the more common type of R & D partnership, namely, contract and grant research agreement which in most cases was a contract between the individual (through the University) and the company.

The study of these cases focused on participants' reasons for involvement in the partnership, their perceptions of benefits derived from participation, problems and challenges in implementing the agreement, lessons and insights derived from their engagement in these partnerships, and other factors that they considered important. It was also hoped that focusing on these key areas would throw light on some of the issues and responses that emerged from the first phase of the study.

The information presented in this chapter is derived from eleven interviews . The first case involved a total of five interviewees, one from the University and four from the company. In the second case study, a total of seven interviews were conducted, two from the University and two from the consortium offices, one from the government, and two from industry whose companies are members of the consortium. The interview data are supplemented by information provided in relevant documents obtained from the participating organizations. These included an examination of brochures on the research programs as well as an examination of the agreement the University and the consortium. Each case study begins with introductory background information, followed by a description of the events leading to the agreement, the perspectives of the interviewees on implementing the partnership agreement (benefits, problems and challenges, lessons), and concluding comments. Finally concluding comments on the two cases are provided..

Case 1: The University of Alberta-Synphar Laboratories Incorporated Partnership

Background

Synphar Laboratories Limited is an Edmonton-based biotechnology company that was established in Edmonton in 1987 as a joint venture between a University of Alberta professor of Pharmacy and a Japanese company, the Taiho Pharmaceutical Company. This was a culmination of previous research collaboration between the professor and the company whereby the latter funded a number of research projects of the professor and his research group in the Faculty of Pharmacy and Pharmaceutical Sciences. In 1987 the professor suggested to the company that they establish a joint venture, and this then led to the birth of Synphar Laboratories as a research and development (R and D) company that would focus on research in the areas of infectious diseases and cancer and the development of drugs to combat these diseases.

In the same year and at the same time, an Alberta-based company, Taiho Alberta, was established in Edmonton as a subsidiary of the Taiho Pharmaceutical Company of Japan. This company would handle all the North American (Canada and United States) businesses for Taiho. Similarly, the Taiho Foundation was established at the University of Alberta to foster and support research collaboration and exchanges in medicine between the University of Alberta and Japanese universities and also to support graduate students. Taiho would contribute $50,000 per year over three years, and this would be matched by the Government of Alberta. The Dean of the Faculty of Pharmacy would be the chairman of the committee that would oversee the operation of the fund. Synphar would oversee the agreements between the University of Alberta and the Japanese universities.

The Synphar-University of Alberta Connection

Following the establishment of Synphar, collaboration between the company and the University continued. The founding professor of Synphar remained in the faculty at the University as an adjunct professor and was joined by another Synphar researcher who also became an adjunct professor in the Faculty of Pharmacy and Pharmaceutical Sciences. In addition, Synphar, as a company, began funding research projects for some of the professors at the University.

The Establishment of an Industrial Research Affiliation Agreement

The connection between the two adjunct professors from Synphar and the University was considered limiting in the sense that only two people were involved. There was a perceived need to broaden participation to cover a wide range of areas other than contract research and the participation of the two people from Synphar. This led to the initiation of an affiliation agreement between the two organizations in 1988 and eventually culminated in the signing of the affiliation agreement on December 1, 1991.

The Process Towards the Agreement

According to available records, work towards establishing an affiliation agreement began at the end of 1987 with a letter from Synphar's lawyer to the Vice-President (Research) regarding a proposed agreement between Synphar and the University of Alberta which covered adjunct professors, graduate students, and post-doctoral fellows. At the beginning of 1988 Synphar was keen to fund the research of the two adjunct professors from Synphar and had offered $40,000 to support graduate students and post-doctoral fellows. The University, however, seemed uncomfortable with this arrangement and asked Synphar "to defer a decision on the treatment of the award until the agreement was in place" and felt that conflict-of-interest guidelines needed to be reviewed carefully.

Meanwhile, there were visits to Synphar by University representatives to discuss the proposed agreement. Between this time and December 1991 when the agreement was finally signed, there were many discussions and a great deal of correspondence between Synphar, the University and their respective lawyers on a range of issues on which they did not seem to agree, such as terminologies used, intellectual property, and publication rights of researchers and students. Thus, there were many revisions and amendments to the draft agreement, and it kept shifting back and forth between the two institutions and their lawyers. It is noted in the records that the draft agreement had to be seen by many interested parties. For instance, towards the end of 1989 a letter from the Office of Research Services to the lawyers reported that a document had been distributed to several individuals for their comments, and their comments had been received, but remarked:

> Since we began the process of review, however, the University has established a new affiliation and spin-off start-up committee (ASSC). This committee will also review the Synphar agreement. . . . This will extend the process; on the other hand, it will ensure that critical individuals in the process are involved in the decisions.

In early 1990 the issue of publication policies was brought in. It seems that these were not discussed earlier, as correspondence from the Office of Research Services to the lawyers noted that the agreement should "reflect the publication policies of the University.

. . . [We are] enclosing the research handbook and the relevant pages." In 1990 reference was made to consulting the Faculty of Graduate Studies on Synphar's graduate student agreement. The negotiations even reached a stage in mid-1990 of frustration by a Synphar representative who, in reference to the Board of Governors-Synphar meeting, noted:

> Negotiations had been friendly but extremely difficult in the organization of the University of Alberta, which reinforced academic values and did not appear to recognize the needs of a commercial researcher. . . . There is no need to enter into an agreement that is more academic than commercial. . . . There is no need to conclude the agreement until the University changes its attitude.

Not until September 1990 was it reported that the University committee -- ASSC had accepted the latest version of the agreement which included all the contentious issues such as the ownership of intellectual property, support of graduate students, and so on. The process of negotiations seems to have continued until December 3, 1991, when the agreement was finally signed.

One of the criticisms of the process leveled by company respondents was the rigidity of the University in handling the agreement. There was the complaint of changes within the University which affected the negotiation process, such that at one time the company was dealing with one person, and the next time another. One company respondent, for instance, stated: "There were unnecessary back-and-forth comments; and not having particularly one person involved in the agreement, we would be negotiating with one person and then another would come on board."

One respondent who represented Synphar in the negotiations noted that "the University operates on a democratic basis with many entities having to approve these kinds of external relationships." This respondent noted further that in the University there are many competing interests that have to be balanced, and "there are so many bodies that have autonomy, that are independent, that have vetoes, it seems nobody has power to get anything done; everybody has power to stop it."

It was also noted that the University policies were formulated from the perspective of the University and did not take into account the needs of the commercial sector, that is,

industry; thus it took time to negotiate some of these aspects. However, on the university side one of the administrators noted that the delay was due to the fact since this was the first affilliation agreement with a company a lot of care had to be taken in working out an acceptable agreement to both parties. The issue of liablity for the University in these kind of involvements needed to be examined carefully. That these agreements had to be examined by the Board of governors contributed to further delays as well.

Ingredients of the Affiliation Agreement

The agreement begins with an introduction of the missions of both the University and the company and states the objectives of the agreement. It states that Synphar was incorporated for the purposes of carrying out research and development in the industrial, pharmaceutical, biotechnological, and related fields. The University, on the other hand, desires to promote interaction between its academic staff members, graduate students, and researchers who have industrial and commercial concerns.

The agreement is divided into four parts:

Part I covers personnel matters pertaining to treatment of University academic staff members and Synphar adjunct professors. In brief, the agreement states that "the University may from time to time and at the request of Synphar assign to Synphar academic staff members of the university." These appointments to Synphar would be for a period of 12 months. Synphar would select from a list of individuals submitted by the University. On the other hand, Synphar would also assign adjunct professors to the University of Alberta whom the University would select from a list provided by Synphar.

This first part of the agreement also covers the intellectual property rights pertaining to the research activities. One of the clauses states that the university academic staff members assigned to Synphar would "enter into such secrecy or non-disclosure agreements as may be provided by Synphar." Further, these researchers would assign to Synphar all

their

> rights, titles and interest in and to any inventions, patents of inventions, works of authorship or other works protected by Copyright Law or other proprietary information arising out of research activities conducted on Synphar premises or funded (in whole or in part) by Synphar.

Part II covers the treatment of graduate students assigned to Synphar or assigned to Synphar adjunct professors at the University. Synphar is to inform the University of the number of graduate students it requires for each academic year and the research program of Synphar adjunct professors requiring graduate student assistance. Synphar may provide assistance to the graduate students selected. Also specified is that graduate students assigned to Synphar Laboratories "shall be supervised by an academic staff member of the University assigned to Synphar."

The agreement also stipulates that intellectual property rights of any student inventions and patents of inventions are surrendered to Synphar. Reference is made, however, to taking into account the university graduate student policies. Further, in accordance with University research policies, the agreement allows graduate students assigned to Synphar to disclose their research results "to the extent required for examination and degree-granting purposes." In the same vein, Synphar may request the University to delay publication of graduate student reports including their theses for up to 18 months according to university research policies or "for longer periods as the university may agree having regard to university research policies."

The second part of the agreement also provides pledges by Synphar to provide the following graduate student awards:

1. Synphar Fellowships
2. Synphar Scholarships
3. Synphar Graduate Assistantships
4. Synphar Post-Doctoral Awards.

Part III covers the industrial research activities of Synphar. In this section Synphar pledges to provide practical industrial experience in its field of research to the adjunct

professors and graduate students. Synphar agrees to provide suitable facilities for them and "shall pay all the costs related to the use of such equipment and materials at the research laboratories of Synphar." Synphar is also expected to promote interaction between full-time research staff of Synphar and other researchers, scientists, companies, and individuals operating in the field of industrial pharmacy, biotechnology, and relevant research and development activities. Finally, the agreement stipulates that Synphar shall pay for all services provided by the university for use by Synphar adjunct professors and graduate students "at current published rates for such services."

Part IV covers the University's entitlement to Synphar proprietary information. In brief, this section clearly states that the university is not entitled to any rights of ownership and use of all inventions or patents of inventions or "other intellectual property owned by or belonging to Synphar exclusively or jointly with others and developed or acquired by Synphar during the term of this agreement."

The Consultants Agreements

The affiliation agreement presented above focuses mainly on the role of the adjunct professors from the company, the funding of their research and of graduate students, and the provision of laboratory facilities for them and their graduate students. It also covers visiting professors on secondment from the University to the company. The agreement provides access to University facilities for purposes of the teaching and research services by the adjunct professors from the company.

The company, independent of this affiliation agreement, has consulting agreements with individual professors not only at the University of Alberta but at other universities as well. These consulting agreements stipulate the terms and conditions of engagement as a Synphar consultants. The focus is mainly on the disclosure of confidential information which Synphar treats as valuable trade secrets. Consultants are expected to pledge to assign and transfer to Synphar their entire rights, titles, and interest in all the innovations they conceive while on consulting engagements for Synphar. At the time of the study, the

company had consulting agreements with seven professors from different faculties at the University. These people were not part of the affiliation agreement.

Experiences of Implementing the Agreement

It has to be borne in mind, of course, that the U of A-Synphar partnership is a result of the company founder's long association with the University as an adjunct professor. To date he and one of the company research directors continue to serve as adjunct professors at the university, contributing to teaching and research in the faculty of Pharmacy and Pharmacy Sciences. The company funds their salaries, some of their research projects and graduate students. The company contributes $ 80,000 annually to support graduate students. Regarding their continuing involvement with the University, one of the faculty administrators noted:

> They make a contribution to teaching; they provide funds to completely support several research programs that their own graduate students are involved in. In addition to that, they have set up a research foundation which is an endowment fund that allows us to utilize the interest portion for academic programs that are independent of their company. So the benefit in the long run to us has been their expertise on our staff and the benefit, most specifically, of the funds coming from the endowment.

The two adjunct professors have two laboratories in the faculty which their company has equipped and fund[illegible]ss to university expertise, direct access to some of the equipment and facilities a[illegible]versity that Synphar did not have were mentioned as benefits that Synphar derived from the partnership. The experience of working in industry and teaching at the same time was considered an invaluable asset by these adjunct professors. On the other hand, the exposure of graduate students to the state-of-the-art equipment and to different types of multidisciplinary research at the company's laboratories was mentioned as one of the benefits to date. The students who use these facilities at Synphar, it was noted, are exposed to both basic and applied research. Thus the exposure of their students to academic and applied research was a rich experience not only for the students, but for the adjunct professors as well

Since the agreement took effect, four graduate students have completed their PhDs under the sponsorship of Synphar although these were not part of the affiliation agreement. Six post-doctoral students have participated in the program since the signing of the agreement and currently there are two doctoral students in the program. One of Synphar's senior scientists reported that his research group had benefited tremendously from two University of Alberta professors who had consulting engagements with the company in the area of research that he heads. The two, he reported, had helped solve some of the research problems relating to drug development. Regular seminars with these consultants from the University to discuss practical problems facing researchers in the company with regard to their areas of research was reported as a common activity. The scientists in the company also benefited from the adjunct professors at the university who were in a position to obtain relevant literature and other materials from the University that they shared with them at the company.

One other benefit that Synphar has gained through the affiliation agreement is access to certain government projects which are only possible through universities. The company has, for instance, been able to engage in collaborative research projects with some universities and companies overseas, with the help of funding from International Development Research Centre (IDRC) that could only be provided through a Canadian university.

Regarding any problems encountered in effecting the agreement, it was reported that the hardest part of the whole process was negotiating the agreement and that there were hardly any problems thereafter. One company respondent elaborated:

> Problems come in negotiating the agreement. Once the agreement is signed, it is basically out of the administrator's hands, and the scientists deal openly and freely ... a copy of the agreement will go to the accounting department so they know the terms and conditions, and the payments that have to be paid....We haven't experienced any problems once the agreement was signed. There will always be bugs to iron out, as was perceived, but in general it hasn't been bad at all.

The "little bugs" referred to above include the complaints about university bureaucracy—irritants here and there such as the slow processing of payments from the company or inappropriate accounting on the part of the University. Reference was also made to expansion in IPC office compared with the past when they had very few staff members and that this contributed had perhaps to the bureaucracy. The University's overhead charges was considered by some interviewees from the company as an issue that needed to be addressed. While they agreed that overheads should be levied by universities, some suggested that the rates should be flexible depending on the nature of the work to be done, how much by the University professor and how much by the company.

Apart from the criticism of the overhead policy and the university bureaucracy, the University policies received favourable comments. One of the company respondents reported, "I think the University policies are pretty good and flexible."

On the lessons gained, respondents in this case emphasized constant communication and regular meetings as extremely important for those involved in projects involving the company and the University. One of the company administrators reported that patience and understanding of the University requirements were important. The experience of working in industry and teaching at the same time was considered an invaluable asset by the adjunct professors.

Respondents in this case study also commented on the environment of university-industry partnerships and noted that it was conducive given reduction in government funding. This is how one of the company administrators explained it:

> I think it is absolutely conducive from the two sides. One is, universities are now facing major cutbacks, so faculties and professors are actively, and aggressively searching for funding and opportunities. And from a company perspective, as I mentioned earlier on cutbacks and restraints on building up your own expertise in-house, companies are looking for tying in with already established expertise. So from both sides, the environment is conducive to collaboration.

Whereas most of the agreement seemed to have been implemented, one part had not, having to do with visitations of professors to industry on a longer term basis, such as

sabbaticals. None of this had occurred yet, and it was hoped that it would eventually take place.

Discussion and Concluding Comments

In this case study, some of the perspectives expressed by respondents in Chapter 6 are brought out. Access to world class researchers at the University, access to equipment that the company did not have and a search for a competitive leverage are some of the reasons given for the company's partnership with the University. On the problems faced, the negotiation process was indeed a long and difficult process. This was confounded further by the University's bureaucracy (red tape) and culture -- the reference to many bodies that have decision autonomy and the power to veto. Issues of intellectual property and overhead costs were also mentioned as problems. As was the situation with other industry respondents whose views are reported in Chapter 6, it was noted by respondents in this case study that once the agreement had been signed, the problems, thereafter, were minimal. Respondents in this case study also praised the University policies governing these partnerships. One of the company administrators for instance noted:

> We have been able to negotiate suitable arrangements for us and the person we are dealing with. Basically when you collaborate with professors from universities, they are interested in publishing, but when you are dealing with a private company, you don't want to publish until it is patented. So those kind of details have to be ironed out, and the University seems to have taken a stance towards understanding the needs of industry.

The environment of university-industry links was considered conducive. Emphasis on constant communication between the research partners, patience, and understanding of each others' requirements were noted as essential for the success of the collaborative projects. Although Synphar had research links with other universities, it was pointed that apart from the reasons given above for seeking to collaborate the University of Alberta, proximity was an additional factor for collaborating with the University. It was noted, however, that the University may not have expertise in all the areas of the company's was interests. Mention was also made that the ease with which the company could work out

these partnership agreements and flexibility of overhead cost charges may weigh in deciding on which universities would be sought for partnership.

Respondents in this case study called for more marketing by the University of Alberta. As one of the company administrators put it:

> To increase industry interactions, there has to be marketing. The University has to take an active role in marketing what they have available. A few universities in Alberta have taken this approach, where they publish a monthly update and send them out across Canada, United States, wherever. So you really have to market what you have from a university perspective.

The other interesting aspect in this case is the large number of University research consultants engaged by the company. Seven university researchers from different faculties and departments of the University of Alberta as of July 1994 had been engaged in contract research with the company. These included two from the Chemistry Department in the Faculty of Science, two from the Faculty of Pharmacy and Pharmaceutical Sciences, and three from the Faculty of Medicine (two from the Department of Medical Microbiology and Infectious Diseases and one from the Department of Biochemistry). This indeed is a very large number of university researchers engaged in consulting research for one company. Although these consultancies are not part of the Affiliation agreement with the University, they nevertheless seem to demonstrate the significance of the University as a valuable resource for local industry.

Case No. 2: The University of Alberta - Telecommunications Research Laboratories (TR Labs) Consortium

Contextual Background

The Telecommunications Research Laboratories, now commonly known as TR Labs, was established in 1986, in Edmonton, as a non-profit telecommunications research and development (R & D) consortium by the University of Alberta, Bell-Northern Research (BNR) Limited of Ottawa, and the Government of Alberta. It was initially called the

Alberta Telecommunications Research Centre (ATRC) and was the first telecommunications research consortium in Canada. The initiative to establish this centre came from the Department of Electrical Engineering, University of Alberta, which wanted to expand their ties with industry. Bell-Northern Research Limited, which is a subsidiary company of Northern Telecom Limited, had a telecommunications research laboratory in Edmonton at the time, and thus a linkage with BNR was feasible and attractive.

According to the initial agreement, the University of Alberta was the sole charter member of the consortium and still retains this role. The consortium was open to membership of other universities and industries as well. Because of its initial promise and success, many other industries and universities have since joined the consortium as members and hence as sponsors. To date, the membership consists of five universities in western Canada, 26 industries, and three provincial governments and the federal government of Canada. Initially most members or sponsors were based in Alberta, but once the membership extended beyond the Province of Alberta, Alberta Telecommunications Research Centre changed its name to TR Labs in 1991 to reflect this broader membership.

The Mission of TR Labs

TR Labs mission statement declares that

> through joint industry and university collaboration in applied telecommunications research, TR Labs will contribute trained people and innovative technology to achieve: economic growth for our government sponsors, business growth for our industry sponsors, academic and research growth for our university sponsors, and personal growth for our staff. (1994 Annual Report, p. 1)

The same annual report states further that it is the vision of the TR Labs board of directors that this institution "will be distinguished by the quality of researchers from industry and academia working productively together creating valued technology, advancing knowledge, and training people for productive roles in Canadian society" (p. 26). One of TR Labs marketing brochures, *The TR Labs Advantage: People and*

Technology for You and Your Business, outlines how members may benefit from this association by:

1) developing and training students and industry professionals for them, who will later act as technology transfer agents;
2) giving them a strategic advantage and a competitive edge through patented innovations;
3) benefiting their business by providing them with information, ideas, options and assessment on technology;
4) pooling together resources and expertise to reduce their risk and allowing them to do more for less;
5) bringing them together with new partners and helping them build relationships that will enhance the growth of their business.

Membership and Sponsorship

Membership in TR Labs is based on payment of a membership fee in cash or in kind. The latter may include services rendered to TR Labs or donation of equipment. Each paid-up member is regarded as a sponsor of TR Labs. There are four categories of membership or sponsorship: the universities, industry affiliate, industry associate, and small business associate.

The university sponsor. The TR Labs brochure, *TR Labs: Progress Through Cooperative Research* states that "the university sponsor regards TR Labs as an accredited extension" (p. 4) of its programs. The university sponsor is expected to make contributions to TR Labs by providing research personnel (affiliated faculty and graduate students) and through other in-kind services such as board and committee representation. The above TR Labs brochure states further that the university sponsor benefits in a number of ways:

1) association with industry sponsors for real and challenging research problems and placement of graduates;

2) access to TR Labs personnel, facilities and connections for expanded teaching and research capability; and

3) improved funding levels and support from government and industry sources.

These three are key factors that contribute to quality and relevance of its education and research programs (p. 4). Because of these anticipated benefits, the following universities have since joined the University of Alberta as members of the Consortium: University of Calgary in Alberta in 1988, University of Saskatchewan in 1991 and University of Regina in the province of Saskatchewan in 1994, and the University of Manitoba in the province of Manitoba in 1993.

Industry affiliate membership. This type of membership is open to large companies extensively involved in telecommunications. It provides the following privileges: access to all TR Labs' technology royalty free, with non-exclusive right to patents, licenses and other intellectual property; and the right to send up to three professionals to TR Labs to work in projects of interest to their company as members of TR Labs research teams. These companies also participate in the Program and Thrust Committees of TR Labs, and have a good representation on the TR Labs' Board of Directors, thereby assisting in setting the direction and priorities of the consortium. The Thrust committees are committees of different research programs based on areas of specialization such as photonics, and wireless communications. The Industry Affiliate Membership fee is $ 2.75 million for five years.

Industry associate membership. This type of membership is open to smaller telecommunication companies or firms whose main business is not in telecommunications. These associate members have the following privileges: access to all TR Labs' technology with non- exclusive right to patents, licenses and other intellectual property for internal use only, and other options for unrestricted use after paying additional fees. They are also represented in the Program and Thrust committees and are allowed to send one professional

to join the TR Labs' research team in areas of their interest. The Industry Associate Membership fee is $ 1.25 million for five years.

Small business associate membership. The third category of industry membership is open to small businesses whose membership fee is subsidized by the provincial government members of TR Labs. Each provincial government pays $1.2 million over five years as a subsidy for small business associates. The annual membership fee for small businesses is between
$3, 000 and $10, 000. The actual fee charged will depend on the size of the company's revenue.

Government sponsorship. The three provincial government members provide direct funding to TR Labs. According to TR Labs brochure, *TR Labs: Progress Through Cooperative Research*, TR Labs benefits the government sponsor by

> acting as an agent of economic development and diversification, directly through its output in people (qualified graduates and professionals) and technology for industry, and indirectly through its role in facilitating business development and building awareness in and visibility in science and technology. (p. 4)

To date there are three provincial governments that are members: Alberta, Saskatchewan, and Manitoba. Since the purpose of TR Labs is to promote R & D activities in the province, the membership fee for provincial governments is negotiated depending on the rate of TR Labs' involvement in the province. Thus the Government of Alberta paid $ 3 million, Saskatchewan $ 2 million for five years, and Manitoba $1.8 million for 4 years.

Once sponsors have paid their membership fee they are no longer required to pay for any service rendered to them by TR Labs. They can only expect services from the consortium in the form of research outcomes and advice that is expected to enhance the business of these sponsors.

Organization and Management of TR Labs

TR Labs is managed by a Board of Directors with representation from the universities and industrial sponsors. The University of Alberta is represented on the Board

of Directors by the Vice-President (Research) and the Dean of the Faculty of Engineering. The President, who is also the Chief Executive Officer (CEO) is supported by three Vice-Presidents, the Vice-President for Business Development, the Vice-President for Administration and Finance, and the Vice-President for Research and Technology. Under the Vice President for Research and Technology are directors in charge of different research areas. The TR Labs research program is divided into five technology areas or foci. For each of these research areas or foci, there is a Research Thrust Committee that has representatives from each category of the sponsors (government, universities and industries). The mandate of these Research Thrust Committees is to formulate research programs in their particular areas, taking into account the needs of the different sponsors.

Program Components

TR Labs Research Program

As was noted earlier, each university that joins TR Labs recognizes it as an off-campus extension of its programs and any research carried out in TR Labs has to be of relevance to the universities' research programs as well as to the industrial sponsors. All TR Labs research projects have to be carried out at TR Labs premises by the university seconded professors, industry seconded researchers, graduate students involved in the TR Labs research program and the TR Labs research staff. Industrial sponsors second their researchers to TR Labs for a period of two to three years. The university researchers are seconded for a period of two years or for the period agreed to by the specific university and TR Labs. It is the researchers from these sectors, together with the students, who determine the research program of TR Labs which should reflect the interests of the sponsors.

TR Labs Graduate Program

One of the unique features of the TR Labs connection is its prominent role in training graduate students. To be a affiliated to TR Labs, a graduate student, must first be

accepted by an affiliate university as a Ph.D. or M.Sc. student in a relevant subject area and be supervised by a professor affiliated to TR Labs. Students are provided with financial support for their studies in addition to other awards that they might have.

Students admitted for the M.Sc. program normally spend the first eight months at the university doing course work. They then spent the remaining 16 months of their program at TR Labs to complete the research portion of their studies. While at the university for course work, the students are expected to supervise tutorials, labs or seminars as a condition of TR Labs support. In addition, they must maintain a high GPA in their graduate courses. Similar conditions apply for Ph.D students including a residency requirement of two years at the university that is required.

TR Labs affiliated students are, in the course of their program, supervised by professors of the affiliated universities, and are registered for the courses and degree programs at one of these institutions. All graduate research programs are coordinated with the interests of the sponsor companies, who also second research staff to TR Labs according to their membership status. In fact, a TR Labs booklet *TR Labs: Networks and Systems Research* (1993) notes that TR Labs students are "integral to the research program" (p. 2) and that these students participate actively in

> 1) understanding the technical needs and opportunities for innovation in telecommunications and related industries;
> 2) exploring novel ideas to further advance telecommunications theory and technology;
> 3) generating new questions which need to be addressed to further the frontiers of knowledge and analysis. (p. 2)

This document further notes that student research is closely tied into front line Canadian research in telecommunications, and students work in an industrial research environment. This industrial environment provides them with "valuable experience and technical training on research projects of direct relevance to the sponsor companies" (p. 2).

The above features are to be found in all the university sponsors. Since the focus of this case is the University of Alberta's connection with TR Labs, an examination of its affiliation agreement with TR Labs is necessary.

The University of Alberta-TR Labs Affiliation Agreement

The agreement, which was first signed in 1986, begins with an acknowledgment of aims of the two institutions regarding the agreement. It states that the purpose of TR Labs is to carry out research in telecommunications and related fields whereas, in the context of the agreement, it also states that the University of Alberta desires to promote interaction between its academic staff members, graduate students, and researchers with industrial and commercial concerns conducting research in the telecommunications and related fields. The agreement is divided into six parts.

PART I: Personnel Matters

This part of the agreement outlines the terms and conditions of assignment of university academic staff members to TR Labs. Basically, TR Labs will advise the University of the number of staff members it requires in the different areas of its research program. The University will provide a list of interested members of staff to TR Labs and the latter will select them accordingly taking into account their academic experience, training, and suitability of the individual's research program. The University will then assign these staff members to TR Labs on a full-time or part-time basis. TR Labs will pay all their salaries and other benefits entitled to them as faculty members of the University of Alberta, and provide them with office space and all the research facilities, equipment and support they will require in their work. All their research work will be done at the TR Labs premises and they will participate in all TR Labs research activities. They are expected to enter into secrecy or non-disclosure agreement with TR Labs concerning intellectual property owned by TR Labs as may be agreed upon by TR Labs and the University. Further, they have to enter into an agreement with TR Labs that they will assign to TR Labs any intellectual property arising out of their research activities on TR Labs premises or funded in whole or in part by TR Labs. These TR Labs staff professors are also expected to teach at the University, as the University may require, taking into account their research load at TR Labs.

PART II: Graduate Students

This part covers the terms and conditions of admission, and studies or research of TR Labs affiliated students. TR Labs will advise the University of the number of graduate students they require for each academic year and the proposed research to be undertaken by TR Labs professors who require graduate students. TR Labs will provide funding assistance and all the facilities and equipment for their studies. These students will be admitted in accordance with the University graduate student admission policies. Each student affiliated to TR Labs will be supervised by an academic staff member of the University assigned to TR Labs. Students, like the faculty members, are also expected to enter into secrecy or non-disclosure agreements with TR Labs concerning proprietary information belonging to TR Labs. Students, however, are allowed to disclose the results of their research to the extent required for examination and degree-granting purposes along with publishing of their research results in accordance with University policies.

PART III: Program Committee, Financial Report and Allowances

Part III of the agreement provides for an advisory body (TR Labs Program Committee) made up of individuals with expertise in telecommunications by virtue of their academic background and business experience to advise the president and the board of directors of TR Labs on its research program. The University is also given the right to advise TR Labs on the research program that the latter should undertake. TR Labs is expected at the end of each financial year to provide a financial statement accompanied by the auditor's report to the University of Alberta Board of Governors.

PART IV: University's Entitlement to TR Labs' Proprietary Information

In this part of the agreement, TR Labs undertakes to provide annually all research information developed at TR Labs including proprietary information to the University for purposes of "allowing the University to use the information in research and educational activities carried out by staff members and graduate students of the University." In the

same vein any information made available to industrial affiliates will also be made available to the University for academic and research purposes.

PART V: University Payroll and Benefits Administration Services

In this part, TR Labs undertakes to reimburse the University for any payments paid by the latter on behalf of TR Labs.

PART VI: General

Here provision for the duration and the renewal of the agreement is provided as well as the course of action to be taken in case of a dispute between the two parties.

Implementation of the Agreement

Faculty - TR Labs Agreement. When the University assigns members of faculty to TR Labs, they have to sign an agreement with TR Labs in accordance with the affiliation agreement. The main items in this agreement as noted earlier are: that all the research work will be funded by TR Labs; and that any intellectual property that the researcher creates in the course of his or her research for TR Labs will be assigned to TR Labs. Secrecy and non-disclosure of proprietary information is also included.

Faculty Positions. Currently, TR Labs fully funds three faculty positions at the University of Alberta. In addition to the three, TR Labs also partly funds an NSERC Research Chair in the Department of Electrical Engineering at the University of Alberta. These researchers are also regarded as TR Labs professors in accordance with the provisions of the University of Alberta-TR Labs Affiliation Agreement. They teach and supervise TR Labs affiliated students, and also do research for TR Labs. The funding covers all their salaries, office space and all their research activities at TR Labs.

TR Labs-Graduate Students Agreement. TR Labs affiliated students also sign an agreement that they will assign any intellectual property that they develop in the course of their research work to TR Labs. This includes secrecy and non-disclosure of

proprietary information owned by TR Labs. Students' research is funded in part by TR Labs but the latter provides full research facilities for the students.

Participants' Perspectives

This section of the case study contains views of seven interviewees: two TR Labs administrators, two university researcher involved with TR Labs, and two industry administrators whose companies are members of TR Labs and a government official.

The TR Labs Advantage

One of the University researchers interviewed described the benefits of working for TR Labs in terms of

> the exposure to a much wider and broader range of research projects and issues in the entire telecommunications field, both as input from the sponsors and via the general discussions through the various research programs. So an organization like TR Labs has a very wide range of research projects that it undertakes, which we wouldn't be exposed to if, let us say, I was doing contract research with only one organization. So it is really the breadth that you get, and I have some times said that what this does is, it "contaminates" your research with relevance. I think that is really the big advantage of working in a consortium environment as opposed to working on a contract for a particular company."

This respondent noted further that TR Labs provides an opportunity for University researchers to work together on projects with individual technical people or researchers from the various sponsor organizations. Thus researchers have an indication of what industry thinks is relevant for them.

An industry administrator from one of the large companies reported that his company had picked up some of the technologies developed at TR Labs and incorporated them into some of their products and services. This administrator further noted that TR Labs acted as a a source of employment of highly qualified graduates for his company and other companies affiliated to TR Labs.. Networking between the university professors involved and industry researchers was considered one of the benefits derived from

participation in TR Labs. This administrator noted further that TR Labs has

> given us a chance to take some concepts that we have developed or are aware of in research and put them into the lab to have them advanced or further researched to see if we can actually utilize them in industrial opportunities.

An administrator of a small company pointed out that it was the access to equipment and research expertise that motivated them to join TR Labs:

> To me it was access that was important, access to people at TR Labs and some of the equipment that they had .... We expect that in the future we will be taking advantage of that to a larger extent than we have in the past .... The people thing is important to a small company. You have got to look at what small companies like ourselves tend to be involved in; it would be ordinary applications. We do applications of microelectronics to specific problems and so on. We don't get involved in the more research type projects. That can be a problem to a company that is growing. As the company expands there has got to be more depth; it has got to be involved in the more fundamental type aspects of research and development. And to do that it needs people with very strong analytical backgrounds, and this is where you need access to academics, to Ph.D.s. Certainly I see TR Labs as a source of these people.

Thus for this small company, the key attraction was the expertise in TR Labs and the equipment.

A TR Labs senior administrator noted that there were four distinctive features of TR Labs that made them different from other university industry interface organizations like the Alberta Microelectronic Centre, the Laser Institute and others. These are:

1) The level of funding from the sponsors (government, industry and universities) is different in that TR labs has a much lower level of funding from the government and a much higher level from industry compared to the other organizations referred to above. In this administrators word's:

> For every dollar that we take in, which we call revenue, on average 45 cents comes from industry, 45 cents from governments and 10 cents from a combination of university and other sources such as interest on money in the bank from holding seminars and conferences. The unique aspect about this particular feature of TR Labs is that only 45 cents of our funding comes from government.

Recent information, however, indicates that this claim may be questioned by other interface organizations that receive government funding.

2) TR Labs operates its own distinctive facility. This, it was noted, made TR Labs a kind of a "half way house" between industry and the university which provided an atmosphere for "true collaboration" joining the culture of the university to the culture of industry. In this respect it broke down the barriers between the two sectors. However, TR Labs in all its sites in the different provinces is located near the university because "the majority of our talent comes from the university, specifically, students and professorial talent."

3) The third feature is pool funding whereby all sponsors contribute funding to the pool through their membership and TR Labs designs research projects in accordance with the needs of these sponsors.

4) The fourth feature is that TR Labs owns all the intellectual property arising from the research projects funded and carried out in TR Labs.

One of the unique features of TR Labs is the training of graduate students in the telecommunications field. These students are exposed to industry research and work not only with the University professors but also with industry researchers. In addition to the university and TR Labs experience, these students are expected to spend four months of practical research experience with one of the industry sponsors and thus enrich their learning. Most of the respondents reported that because of these field experiences and contacts in the industrial environment, most students have found employment with the same firm in which they carried out their research, indicating that the companies were impressed with their capabilities. TR Labs believe and so do the respondents that students are the best technology transfer agents.

Problems and Challenges

The issue of intellectual property was mentioned by TR Labs respondents as one of the recurring contentious issues that has to be dealt with, especially with regard to university researchers. One of the TR Labs administrators reported that some professors were not willing to do research for TR Labs because they were reluctant to give up their

intellectual property rights. This administrator reasoned, however, that the joining of the consortium by five universities and the participation of 40 university researchers from these five universities doing research for TR Labs was enough recognition that they (universities and their respective researchers) were benefiting from this involvement. According to the two TR Labs administrators interviewed, TR Labs considered the intellectual property issue as a challenge and had already instituted a number of options from which a researcher could choose. One of these is acceptance of an annual sum of money in lieu of intellectual property rights. The second option is that the intellectual property will revert back to the researcher (inventor) if no one takes and develops the idea or the invention within three years. The third option is for the researcher to participate in the royalty stream once the intellectual property has been licensed by the TR Labs to a third party.

The other problem noted is the delay of completion of theses by TR Lab students who obtained employment before completing this part of their program. This was attributed to the high demand for them by the industry sponsors of TR Labs who, on realizing how good they were, offered graduate students employment while they were doing field research in their companies.

Another concern mentioned is the lack of participation of some members in the thrust committees. Since these thrust committees are responsible for research projects in their respective fields, it means that those member firms that do not participate in them are unlikely to have their areas of research interest or problems examined. This is how one respondent put it:

> If you are not careful you will find that an industrial member will join TR Labs because it seems to be the thing to do, and not put enough emphasis and interest in the thrust committees to actually extract out of the labs some important data. And so we had cases where we had to go back to company A and say: You indicated that you have a person in the thrust committee. No one ever shows up at the meetings. Are you sure you are getting value for your money? And you find that if you go high enough in the organization they finally name somebody. We are worried that in three years from now, when their membership comes up for renewal they will say, "Well, we never got anything out of it."

One of the challenges which the consortium faces is how to assist small companies in product development. This is because TR Labs generates research knowledge up to some point and it is up to the industry sponsors to pick up that knowledge and develop it further for their own use. Whereas large companies (Industrial Affiliates) typically have resources for further development, the small companies (Small Business Associates) may not have the resources to do so. It should be noted of course that the Small Business Category is the most restricted in terms of privileges gained from their membership. For instance, they don't have sufficient resources to second researchers to TR Labs, as is done in the other categories of membership.

Concluding Comments

As was stated at the beginning of this Chapter, it was hoped that examining the two cases would: (a) provide illumination on some of the items covered in the first phase of this study; (b) provide perspectives of those involved in these two types of partnerships, given that the two specific partnerships went beyond the normal individual research contract and grant partnerships.

Similar to what has already been noted in Chapters 5 and 6, access to expertise and state of the art equipment remain the motivating factors for participation in the partnerships. However, there is the added dimension in TR Labs case study of the uniqueness of its research programs, namely the pre-competitive research as explained earlier, and its own environment which allows for the bridging of two cultures, the university and industry. In both cases, it is acknowledged that the environment of university-industry partnerships has improved. One issue that clearly emerged from the two case studies concerns intellectual property. It was acknowledged that this was a contentious issue that appeared not to have permanent solution. However, despite this, some arrangements had been worked out for those who had agreed to participate in the partnerships. The problem of "red-tape" in university bureaucracy was cited in the Synpar Laboratory case study although it was

pointed out(as it was in Chapters 5 and 6) that once the research agreements had been signed, these red-tape problems were minimal. However, the issue of beauracratic tie-ups at the University were not mentioned at all in the TR Labs case study. One possible reason for this is that most of the research and related operations are conducted on the TR Labs premises. The problem of university reward incentives for academics to become involved in industry research was also cited by some of the respondents in the second case study.

The problem faced small companies as cited in Chapter 5 and 6 regarding the lack of adequate resources to participate in these partnerships was also noted in the case studies reported in this chapter. For instance, it is interesting that even though the issue of having enough funds to compete with large companies for the best university researchers, seemed to have been largely resolved by pool funding in TR Labs, the fact that these small companies cannot afford to second researchers to TR Labs, as the large companies were doing, was seen as a disadvantage.

The explicit inclusion of graduate students in the agreements in the two different partnerships is an area of strength. This is especially so with the TR Labs case where there is a specific designed TR Labs Graduate program which is there on its own merit and not because a contract was struck between a university researcher and a company or TR Labs. The size of the graduate program too and the appeal it has to industry, given the high demand for these graduates, was generally recognized as a testimony to the importance of graduate students as the best agents of technology transfer from the academy to the industrial work place.

CHAPTER 8

ANALYSIS AND DISCUSSION

In this chapter the major findings of the study are examined in the light of the existing literature on university-industry collaboration on research and development. To what extent do these findings illuminate, negate or conflict with the current knowledge of these relationships? What new perspectives or dimensions emerge? The original research questions as well as the issues and themes that emerged from Chapters 5 and 6 are utilized as headings for the analysis and discussion. First, the initiation of the partnerships with special attention to the factors that motivated their formation is discussed. This is followed by a review of issues related to the organizational structures, the policy framework, problems that face the partnerships, and the challenges faced and lessons learned. Finally, a discussion on what needs to be done to enhance these research collaborations and a summary of the chapter are provided.

The Initiation of Partnerships

It was noted in Chapter four that most of the research and development partnerships at the University were in the form of research grants and contract agreements. In Chapters 5 and 6 it was noted from the interviews carried out that some of these partnerships were initiated by the university's researchers and others by industry. In those situations where the initiation came from industry, it was the industry researchers or research administrators in charge of the research programs who determined the need to seek university assistance in the form of collaborative research. This happened in situations where the company did not have expertise to undertake the project in-house. Some university researchers noted that they were not aware of any research contracts that had been initiated by the administration and that most research collaborations of which they were aware were initiated by the researchers themselves. For those initiated by industry, some had been advertised in

journals as requests for research proposals. Some of the respondents sent out unsolicited proposals to industry, although not all were successful. A number of University respondents questioned the role of the Intellectual Property and Contracts Office (IPCO) in facilitating links with industry, noting that through available computer bases, they were able to access whatever research was currently going on in their respective fields of study. Regarding the overall profile of research and development grants and contracts, the University did not have the statistics on which partnerships were initiated by the administration, the researchers, or industry.

The level of awareness of what each organization has to offer the other has been emphasized as important in the interorganizational relations literature. As noted in Chapter 2, different levels of awareness were identified: the level of awareness between the directors of the organizations and the levels of awareness between the personnel or staff members of the organizations (Hall, 1982, p. 249; Klongcan et al., 1976). Van De Ven (1980) emphasized that higher levels of awareness are likely to result in higher levels of interactions. Glaskiwiz and Shatin (1980) emphasized the importance of interpersonal ties in interorganizational relations. The level of awareness involving interpersonal ties among organizational personnel is based on old school ties, membership in professional organizations, simple friendships, or contact based on work situations, etc.

The awareness factor seemed to have played a significant role in the initiation of the partnerships that were studied, as was described above. Indeed, the initiatives taken by researchers and administrators from both sectors were based on awareness of the potential sources of interorganizational dependence in terms of resources and services that each sector could offer the other. In fact, a few research contacts were initiated due to old ties or connections made in other circumstances (friendship or schoolmates).

The importance of the awareness factor is further strengthened by the complaints of some respondents from industry that they were unaware of what the university had to offer. This is how one industry administrator put it: "The University doesn't sell itself

very well; it sort of expects people to be wonderful." Similar sentiments were expressed by some of the university respondents. This is the reason that respondents from both the university and industry sectors emphasized the need for marketing by both sectors so that each could know what resources and services they could offer to the other.

The awareness factor appears critical to the initiation of partnerships. Computer databases on the different research activities undertaken by scientists in both the university and industry sectors can be useful in this respect, and some researchers reported that they made use of these resources. IPCO maintains computer databases in some of the research fields and utilizes them for faculty members who need them. However, the reports of most industry respondents that they did not know what the University had to offer them means that these databases although useful do have their limitations.

Motivational Factors for Partnerships

The motivators for universities and industries to participate in university-industry research were detailed in Chapters 5 and 6. In summary University respondents reported that these research partnerships (a) provided a source of research funds, (b) whetted their intellectual curiosity--to do research, (c) served as an avenue of commercialization for their research results, (d) afforded the opportunity to do applied research, (e) were a means to build academic profile and enhance career development, and (f) provided practical examples to enhance their teaching. The motivators identified by industry participants, on the other hand, were (a) their attraction to fundamental research, (b) the expertise available at the university, (c) their attraction to inventions and discoveries already made, (d) the university's potential for knowledge transfer that would boost their competitiveness, (e) the availability of specialized facilities and equipment, (f) the cost factor, namely, they felt that they would receive greater value from university research than from that done by consultants.

The reasons given for collaboration in such partnership activities conform with the motivational factors for university-industry linkages that are reported in the literature.

Melchiori (1983), Matthews and Norgaard (1984), and Fairweather (1988) all cited a source of funding, access to specialized equipment, solving industry problems, income from patents, and decline of government funding as motivational factors for universities. What emerged as new points of emphasis on the part of university researchers were intellectual curiosity and building of their academic profiles. These reasons are significant because they contradict what the critics of university-industry research charge as negative consequences. When the study respondents referred to intellectual curiosity, they are talking about fundamental research, which is the traditional tenet of university scholarship. Bok (1982, p. 152), Wasser (1980, p. 1112), and Buchbinder & Newson (1990, p. 364) reported that funding for university-industry research favors applied research over basic research, compelling researchers to do the former rather than the latter. The point here too is that some researchers engage in university-industry research because they find this kind of research to be intellectually challenging. As one researcher pointed out, funding by industry enabled university researchers to pursue their research dreams.

Industry's interest in fundamental research. The other interesting finding of the current study is industry's recognition of the importance of the fundamental research that universities do. As was explained in Chapter 6, the caution by some in industry that universities should not let fundamental research be undermined by their quest to pursue applied research is contrary to what is normally believed to be criticism of universities by industry—that they are ivory-tower places doing research that is irrelevant to societal needs and problems. As one industry respondent noted:

> Our philosophy as a company is that we feel universities do have a role in terms of technology invention and fundamental knowledge development. We at this point still distinguish a university as a role where they can provide and do more ... fundamental science in a far better way than we are positioned to do at present.

In fact, concern was expressed as to "whether or not we are not sacrificing our capability in fundamental research by having an element of commercialization involved in some of the work activities that universities are getting involved in today than in the past."

This concern was voiced by a respondent from industry who places high value on basic research.

Commercialization of university research results. Some University researchers were interested in becoming involved in university-industry research as an avenue for having their research results commercialized. Although industry respondents had no objection to commercialization of research results, concern was expressed about the potential of universities to provide competition to the same companies that funded them. As one industry respondent stated:

> If the commercial aspect is pushed too far, it approaches a position that is much more competitive than it is collaborative or complementary. If the degree of competition is too high, then the advantages that we see for a university start to disappear, which means we simply do it ourselves.

The key issue in this statement is the essence of collaboration -- the fact that in engaging in cooperative research and development between the two sectors, the collaborative element is not forgotten. The emphasis seems to be on striking a balance between the two extremes.

Funding as a motivational factor. It was unanimously agreed that funding for university research, providing specialized facilities and equipment, as well as funding for graduate students, were some of the reasons for engaging in industry research by university researchers. The funding element is well documented in the literature already, as mentioned at the beginning of this chapter. While acknowledging the importance of funding as a motivational factor, some respondents welcomed having industry provide an additional source of funding rather than depending on one source, the government. Some industry respondents were happy with the government cutback in research funding to universities arguing that this would force the universities to seek industry support and thus in the process help industry with its research problems. On the other hand, some respondents from both sectors cautioned that universities should not put too much weight on university-industry partnerships as a source of funding research support. This was because industry contributed a very small percentage of overall university research funds .

These respondents identified the educational and research contributions as being more important than the financial contribution. As one industry administrator stated:

> I am not denying that performing research and grants for research are useful for educational purposes; indeed, it most definitely is. But I am not sure people are really sizing the royalty-intellectual property aspect of what universities do very well. And the fact of the amount of money universities earn from their technology transfer and royalties is insignificant in terms of their operating costs and in terms of the investment that goes in.

Organizational Structures for Collaboration

As was noted in Chapters 5 and 6, respondents from the university and industry sectors commented on the adequacy or inadequacy of the existing organizational structures for partnerships. Most of the comments were on the university structures rather than structures in industry. Whereas the majority of university respondents focused their comments on university structures, some industry respondents commented on structures in both sectors. The following is a summary of these perspectives.

University perspectives

- Current organizational structures are adequate/inadequate.
- There is a need for less structure between researcher and the client (industry).
- There are too many structures.
- The structures are bureaucratic.
- University administration should play a supportive role, not a leading role.
- There is no structure that recognizes how contracts come about.
- The staff in IPCO should be reduced.
- Researcher-to researcher interaction between the two sectors is most important.
- Faculty structure is adequate but needs support (a liaison person).

Industry perspectives

- Some companies are putting together an integrated approach to collaborating with universities.
- University decision-making process is bureaucratic and diffused.
- University structures do not encourage commercialization of research (lack of academic reward structures for this).
- Universities are not structured in a way that encourages academics to get involved in industrial liaisons.
- University offices of technology transfer are inappropriately motivated (focus on what universities have rather than what the market wants).
- One-to one relationships between university researchers and industry personnel are extremely important.

It is evident from the above that all the respondents acknowledged the importance of organizational and coordinating structures for research and development partnerships. Although some felt that the current structures were adequate and provided satisfactory or adequate services, others felt that more improvements were needed. Two themes or issues emerged from the respondents in both sectors (a) the perceived bureaucratic nature of the university, and (b) the role of IPCO (the liaison office).

A great deal of doubt was cast in the literature about the suitability and effectiveness of the traditional administrative structures at universities in providing and enhancing linkages with industry. As was indicated earlier, Matthews and Norgaard (1984), for instance, noted that the "outmoded structures of university administration" (p. 99) were an obstacle to successful alliances with industry. Fairweather (1988) observed that research liaison offices had been created in universities to facilitate the interactions with industry, because academic departmental structures had been created for teaching purposes and were not suited for research liaisons. The findings of this study indicate that a liaison office existed, and yet there were problems associated with it. Bearing in mind that all of the university researchers interviewed participated in collaborative research with industry from their departments, one might call into question what role the departments can play. Although the role of the research liaison office was supported by the respondents, there seems to be a shift now towards placing the liaison personnel in faculties so that they are closer to the researchers rather than placing them in central administration. Two faculties were already in advanced stages of placing research liaison officers in the Dean's office, where they would be answerable to the Associate Dean (Research). Cerych (1985) observed that industrial liaison offices that universities have established are

> intended not only to maintain liaison with firms as regards seeking contracts, prospecting the market, and the establishment of contacts with the appropriate university departments or staff members, but also to serve as an administrative framework for legal and accountability matters which arise in the course of seeing a contract through. The main aim of these offices may thus be regarded as to overcome or, where possible, even to by-pass the difficulties and administrative or legislative bureaucracy often associated

> with the traditional university context in the hope that these may give way, within universities, to more businesslike, industrial-type attitudes. (p. 14)

Whereas the findings of this study support the role of liaison offices as described above, they also contradict some of them. The liaison office at the University studied was considered by the respondents to be a constituent segment of the University's central administration and a principal part and parcel of the bureaucracy about which the respondents complained. The role that Cerych (1985) prescribed for the liaison offices, that of "by-pass[ing] the difficulties and administrative or legislative bureaucracy" was not supported by the respondents' perspectives. That respondents in both sectors emphasized the importance of researcher-to-researcher interaction over the role of liaison offices is a further testimony of the wide range of opinion concerning the role that liaison offices play. Most university respondents noted that they had obtained their research contracts through their own initiative rather than through IPCO. As one respondent put it: "In my experience I have not yet found a contract that was initiated by the administrators." Despite this, however, some of the university researchers who supported the current role played by IPCO, noted that they had a heavy enough workload in teaching and research and did not have the time to perform the functions that IPCO did for them. The role of industrial liaison offices serving "as an administrative framework for legal and accountability matters" (p. 14) in contract arrangements was also supported by some of the respondents. "Providing a legal framework," "administrative support," and "a supporting role and not a leading role" were some of the comments made about the role of university administration in collaborative research.

As indicated in Chapter 5, some university respondents appreciated the role that the liaison office played in their university-industry interactions and felt that this office was understaffed, whereas others perceived the office to be overstaffed and as needing to be reduced in size. Those researchers who already had research reputations were able to interact with industry without assistance from IPCO. This confirms what Stankiewicz (1986) noted when he reported that it had been observed that "some academic scientists

with well-developed contacts with industry see liaison units as superfluous or even objectionable" (p. 52). This feeling about the University liaison offices was reflected in the present study by one university researcher who as was reported earlier in Chapter 5 stated:

> They are a total waste of money. All they do is impede any connections. They need only two people to take care of the entire university, and they should fire everybody else. . . . I used to be on their committee, but they don't invite me any more because every meeting I started saying, "This is a waste of time," and it is. So if they cannot help me as a scientist, fine. A drug company knows me and I know them, and these people don't know anybody in industry.

Tietel (1989) noted that university liaisons have "less autonomy in dealing with companies because a greater decision is retained by the individual faculty members and departments" (p. 51). However, the University researchers interviewed did not perceive themselves as having this autonomy in the sense that final approval for their decisions to collaborate with industry was not obtained from departments but from the University administration, although the department heads and faculty deans had to provide initial approval. In fact, most of the respondents from both sectors, as was observed earlier, noted that things moved fast until they reached the hands of the administrators who put some restrictions on them. One industry respondent explained about finalization of a contract research agreement:

> In the initial contacts with the university, we always find the faculty willing to participate and work with us, but we have had to work a number of issues through the Intellectual Property and Contracts Office, and it has been somewhat detrimental.

It will be noted, however, that the role of liaison officer is to ensure that University policies and guidelines governing university-industry partnerships are adhered to. It would seem, therefore, that perhaps in performing this role, making sure that research agreements are made in accordance with these guidelines, may be perceived by some of the researchers as being too stringent.

Who Should Play the Boundary-Spanning Roles?

In Chapter 2 the boundary-spanning activities of colleges and universities were summarized (Seymour, 1989, p. 11). These included:

1) Representing: involves presenting information about the organization and its environment in order to shape the opinions and behaviors of others. (In the context of the current study, this might include marketing the university's research technologies or research potential and other universities' research and development activities and services.)

2) Scanning: an organization's search for major discontinuities in its external environment that may present opportunities or constraints. (What are the opportunities or obstacles for research and development with the private sector?) However, Seymour noted that the discipline-driven nature of universities makes it difficult to balance the environment of the university as an institution with the semi-autonomous disciplinary environments. He also referred to the loose coupling of universities as problematic in handling a university environmental response given its disciplinary sectors.

3) Processing information and gatekeeping: involves interpreting information of the environment in terms of opportunities, constraints, and threats. (In terms of research and development partnerships, what are the opportunities, constraints, and threats?)

4) Linking and coordinating: Who should play this role?

5) Protection as a boundary-spanning activity: involves protecting the organization's sphere of influence against control by others, etc. On this Seymour (1989) cautioned: "While overprotection will cause an organization to lose touch with its external environment, underprotection can create steady dilution of an institution's mission and social system" (p. 20).

A fundamental question emerges: Who should play all the above boundary-spanning roles—liaison officers, central administrators, faculty administrators, or researchers?

Representing. This involves presenting information about the organization that will shape its opinions and behaviors; it seems to be a public-relations and marketing function. There was consensus from participants in both sectors that marketing by university and industry was necessary in order to extend partnership arrangements. The premise, as noted earlier, was that industry did not know what the university had to offer. One of the functions of IPCO is the marketing of university technologies. Yet the effect of this function or of the office with regard to marketing was not felt by the industry respondents interviewed.

Stankiewicz (1986) listed the marketing function as one of the roles of liaison offices recommended by the 1982 Stockholm Workshop and stated that "the liaison units should adopt an active marketing approach rather than a passive service-on-demand approach" (p. 53). Seymour (1989) noted further that university researchers do play this boundary-spanning role when they conduct research for industry and provide other consulting services (p. 12). Marketing of research and development is, however, an area that still needs to be addressed by the university: Who should actually do it, and how? Some faculties, through the initiation of the roles of Associate Deans (Research), have organized university-industry sessions to publicize research programs in their faculties, and the media have given publicity to some of these. One Associate Dean (Research) pointed out that he has always tried to interest industry executives in what goes on in the faculty whenever he has had opportunities to do so.

Processing information and gatekeeping. In terms of this boundary function—interpreting the environmental information in terms of opportunities, constraints, threats, and contingencies it poses for the institution—there seems to be no specific body assigned this responsibility. With regard to research and development, the Office of the

Vice-President (Research) is expected to provide some leadership in this area. However, as was noted earlier, because of the loose coupling within universities and their discipline-driven nature, these roles may also be played by faculty and departmental administrators. It was noted in Chapter 4, for instance, that the Vice-Presidents (Research and Academic) had urged the University Research Policy Committee to examine two national reports on research (e.g., *The Royal Society of Canada Report: Realizing the Potential : A strategy for University Research in Canada* ,1991; *Inquiry Into University Education in Canada* , 1991) to determine what implications the contents of these reports might mean to the university. Furthermore, university respondents felt a sense of competition with other universities for industry collaboration and urged more proactive strategies. A statement by one university respondent illustrates this point:

> I would like to see the university at least try a marketing process of some sort. Maybe you know better what is happening at the university, but it seems to me that their model (in another local university) might be better than ours, might be more effective. At least they have a way of sending out information to companies on a regular basis about new technologies that have been reported on their campus and at least are drawing these to the attention of potential customers. I don't think that is happening at our university. If it is, at least I am not aware of it happening here.

There was an awareness, therefore, that more should be done to foster university-industry interaction, but how to go about it did not seem to be very clearly outlined. Seymour (1989) noted that the problem is not a lack of information about the environment (although in this study participants' knowledge of the research and development environment is not fully clear), but "the inability to translate critical information into a range of strategic responses" (p. 15).

As was noted in Chapter 2, one of the contentious issues in university-industry partnerships is the danger of erosion of institutional autonomy and control of the research agenda by industry. This extends to the protection of academic freedom, ensuring a balance between basic and applied research, time and resources devoted to teaching, and resources devoted to industry research (Seymour, 1989, p. 20). This is where the boundary-spanning role of protection becomes important. According to the current study,

this is a role that has been played by both administrators and researchers in the University sector. Some of the University respondents referred to opposition to university-industry research by some of the older professors. Some called them "the old guard"; there was a cognizance too that not everybody in academia or in the departments or faculties that was involved in university-industry research supported these activities. This was considered healthy and regarded as a check serving to remind others of the main mission of the university. As was reported earlier, one university faculty administrator stated:

> I think there is some value in the arguments of people who are opposed to it [university-industry research], because I think they bring a balance. I would hate to see it all go one way, so I think we need a balance.

These opponents of partnerships provide an element of "protection," in a sense. An examination of the minutes of the Board of Governors revealed expressions of caution about the University's involvement in these collaborative research activities. In some cases the agreements had to be reworked because they did not sufficiently emphasize or clearly bring out the expected educational benefits in them. IPCO has to make sure that university policies and regulations are followed in research agreements between the university, professors, and companies. This is indeed a protection role. The associate deans interviewed noted that they did not play a policing role but expected the researchers to abide by the policies and regulations governing university-industry research. A great deal of integrity is therefore expected of the researchers.

Policy Framework

As has been noted in Chapter 2, policies play a crucial role in providing the necessary climate and guidelines for research and development interactions between the two sectors. It was noted that the emergence of university-industry partnerships has led to debates about the impact of these linkages on academic freedom and university autonomy, on issues of conflict of interest, on the imbalance between basic and applied research, and

intellectual property rights. In response to these concerns, supporters of these partnerships contended that the establishment of clear policies and guidelines should counteract and minimize the possible negative impacts (Bok, 1982, p. 168; Langfit et al., 1983, p. 173; Millard, 1991, p. 246). Bok (1982) supported debates on policies and guidelines, saying that "universities can do much to contain abuse by working with their faculties to develop reasonable guidelines and restraints" (p. 154). These writers have emphasized that in drawing up partnership agreements, care must be taken to ensure that the agreements benefit both sides and that they do not threaten the traditional values of the university. Limitations on secrecy, conflicts of interest, proprietary rights, patents, and publication rights need to be addressed in clear institutional policies and carefully drawn contracts with industry (Millard, 1991, p. 247; Rosenzweig & Turlington, 1982, p. 138). Millard emphasized further the importance of a code of ethics for faculties and departments that have partnerships (p. 248).

The findings from the current study do indeed indicate that policies on university-industry partnerships exist in both the government and university sectors. The study did not find any explicit policies on these relationships by industries studied.. These did not emerge clearly in the interviews as did the university and government policies. The university and government policies were described in Chapter 4. The university's policies were comprehensive and covered all aspects of university-industry collaborative research. Although some of the respondents from both sectors acknowledged that they were not very familiar with the details of university and government policies governing university-industry relations, most agreed that these policies were "good," "flexible," "reasonable," and "acceptable." Some of the university researchers who had been involved for a long time in these research linkages commented on the policies, noting the frustrations they experienced as these policies were being developed.

The federal government programs such as NSERC, MRC, and IRAP that supported university-industry research were frequently mentioned and acclaimed by the

participants from both sectors. The tax incentives offered by the government to industries that funded research in university were also lauded.

There was, however, one policy that received mixed reviews from respondents in both sectors. This was the university policy on overhead costs. Interviews from both sectors noted that the formula for charging overhead costs was not clear. Some industry interviewees felt that the rate of 40% charged was too high and that it should depend on the nature of the project being undertaken. One university respondent described the action of assessing uniformly large overhead costs as "killing the goose that lays the golden egg." Some university respondents, however, agreed with the whole idea of overhead costs and noted that, compared with what companies would pay consultants for research, university rates were comparatively cheaper.

The University has given serious thought to the question of overhead costs. In 1992 the University's Research Policy Committee established a subcommittee to examine this issue. The committee examined the rates charged by other universities and found that the University of Alberta's rates were within the ranges charged by other Canadian universities. The literature on research and development collaboration between universities and the private sector did indeed cite overhead costs as one of the contentious issues (Carboni, 1992; Barrington, 1993).

The University-Industry Partnerships Environment

Respondents from both sectors described their perceptions of the current environment in which university-industry research partnerships operate. The terms used included "excellent," "conducive," "good," "better than in the past," and "more open but cautious." Some felt that there was still an element of mistrust as to each other's goals. Some preferred to talk of the internal environment (within the university) and the external environment (outside the university). They described the internal environment as conducive, whereas they felt that the external environment was wanting, given the government cutbacks and lack of coordination between government departments. Although

some faculty members saw government funding cutbacks as an obstacle, some in industry welcomed it, contending that they would force the universities to look to industry and be more concerned with industrial problems than they had been in the past. As was noted in Chapters 5 and 6 respondents from both sectors acknowledged that, in general, the environment had improved and that there was a better attitude towards the whole concept of university-industry partnerships than in the past.

Partnership Problems

The problems perceived by participants involved in university-industry partnerships were discussed in Chapters 5 and 6. These can be summarized as follows: (a) attitudes, (b) unrealistic expectations from the partnerships, time-factor problems, and intellectual property rights, (c) keeping focus on research-problem and constant communication level, (d) bureaucratic structures affecting decision-making processes, (e) Overhead costs, f) small companies' feelings of neglect, g) conflict of interest , and (g) inadequate University reward structures

Attitudes

Although respondents reported that there had been dramatic improvement in the attitudes of industry and university personnel towards each other, some respondents felt that there were still traces of negative attitudes towards one another. The image of the university as an "ivory tower"—that the university was not "sensitive" to industry needs and failed in its occasional attempts to get university involved in some industry problems. As indicated in chapters 5 and 6 some University researchers still regarded industry money as "tainted money." One industry respondent noted that those who were involved in university-industry research were regarded as "having sold their souls!" Thus within academia one does find faculty members who are opposed to industrial links and are critically disposed towards fellow researchers who are involved in university-industry research. Although the modes of expressing the critical attitudes were not explicit, these

contrary attitudes were present. Records of minutes of members of a university-industry working group in one of the faculties indicated that they acknowledged the fact that not everybody in the faculty supported university-industry research.

The problem of attitudes (universities towards industries and vice versa) was explored in Chapter 2. The "ivory-tower" (Matthews & Norgaard, 1984, p. 49) tag given to university researchers by industry and the "profit/money mania" (Millard, 1991, p. 184) tag given to industry were very much emphasized. It can be summarized here that, although the negative attitudes toward cooperative university-industry research are still prevalent, there have been many improvements in this area, as reflected in the increase in the number of partnerships over the years.

Unrealistic Expectations, Time-factor Problems, and Issues of Intellectual Property

One of the problems identified by respondents in both sectors was the length of time taken to conclude or finalize research agreements. The respondents complained of the levels of approval through which these agreements have to go, including the time taken by lawyers. The negotiations on issues of intellectual property rights contributed to the time delays. Some industry respondents reported that university researchers tend to "overvalue the intellectual property that might come out of their research, ignoring the amount of time and resources still required to develop that intellectual property to a marketable product." Besides, it might not be economic to develop some research discoveries for commercial application. On the other hand, the university researchers noted that to develop the knowledge or ideas to the level of discussion with industrial partners would normally have taken a long time and the expenditure of a large amount of resources, and thus industry tended to undervalue that aspect of the work that has gone into the development of the idea. One university respondent noted that researchers "should not sell themselves short." The issue of intellectual property was a problem only in negotiation of the contracts, but there was no dispute about the ownership and licensing of patents as explicated university

policies. In fact, most respondents from both sectors stated that they were satisfied with the university's policies governing intellectual property. Some companies have even gone to the extent of funding research through grants and agreeing with the researchers that the company be given the first right of refusal. In other words, they will have first priority to use whatever results are available from the research.

There was concern, however, about universities "becoming more and more protective of their technology position and other rights." Most companies reported that despite the obstacles in the negotiations, they had been able to work out "satisfactory compromises which were beneficial to both parties." Most acknowledged that once the initial agreement had been concluded, subsequent agreements were always easier to strike. "Once you have gone through it with the university, it is a lot easier the second time round," said one industry respondent. Subsequent research grant or contract agreements have therefore been easier, in cases of renewal. This would seem to underscore the importance of standardization, which is the development of similarity over time in the procedures used for the transactions between the collaborating organizations (Van De Ven, 1980). The issue of intellectual property, however, is an aspect of the negotiations that will likely continue to feature prominently. As has been noted, respondents from both sectors were satisfied with university policies governing intellectual property rights. Matthews and Norgaard (1984) in fact observed that "a consensus is developing that intellectual property rights are a manageable issue" (p. 186). Indeed, the perceptions of respondents in this study indicate that, although they are a contentious issue, research agreements have continued to be made and renewed.

Keeping Focus on the Research Problem and Constant Communication

Some industry respondents reported the research program that was agreed on has on occasion drifted away from the original intent, and this was, in most cases, because of a lack of constant communication with the researcher. Some, however, reported that they kept in regular contact and exchanged progress reports about the development of the

research project. Those who kept in constant communication had not encountered any problems. Intensity, which refers to the degree of interaction between organizations forming a partnership, is considered a factor contributing to the strength of the relationship (Van De Ven & Ferry, 1980). Those who kept in constant exchange and dialogue did not encounter any problems. This is one of the lessons that some respondents stated that they had learnt. This is also the reason that a number of industry respondents reported they had a contact person within the company to keep the program on track "so that we don't just send money and wait for a report to come back in two years. We want to have an ongoing dialogue—we want to have collaboration." The emphasis for success of the collaborative venture, therefore, is on constant communication and dialogue. That is definitely the essence of what partnerships are about.

Bureaucracy of University Administration

As was noted earlier, respondents from both sectors identified university bureaucracy as a contributing factor in delaying the processing of research agreements. Some complained of a lack of a clear locus of authority, as one industry respondent noted: "It is very hard to find who has the ultimate authority . . . too many questions, too many committees, and too many boards to get a final decision". There were complaints of "long-term negotiations," "red tape," and "layers of administration." Others called it the curse of democracy. Some noted that "the university should learn to do business." An interesting observation from this study is that faculty administrators seemed to considered themselves more as researchers, scholars and teachers than as administrators. To differentiate faculty administration from university administration, some preferred to use the term *central administration* to refer to the office of the Vice-President (Research) and other administrative officers who were not directly involved in teaching. Indeed, a lack of flexibility in university structures (Matthews & Norgaard, 1984; Cerych, 1985) and the differences in organizational-behavior norms and processes between the two sectors (Matthews & Norgaard, 1984; Melchiori, 1982) were pointed out in Chapter 2. Two

observations made by Cerych (1985) and Matthews and Norgaard (1984) seem to summarize the perceptions of the respondents in this study. Matthews and Norgaard (1984) noted that partnerships at the individual levels have been successful but are normally hampered by administrators and lawyers. This is how they explained it:

> Partnerships seem easy at the grass-roots level. You sit down with a faculty member or executive, you define the problem, you shake hands, and go out and do it. "But when lawyers, sponsored research office, and other administrators become involved, the complications grow exponentially. (p. 76)

On the same theme, Cerych (1985) pointed out that

> universities are more often than not subject to cumbersome legislative and administrative machinery, a feature which is criticized with greater frequency than any other by people from industry and explains their preferences for informal arrangements. Here there is a special dread of what is seen as slowness of decision making in higher education. (p. 16)

Hardiman (1994) emphasized the same view:

> University governance, particularly the governance in traditional universities, is perceived by the corporate sector to be largely unchanged over the years. University governance is seen by business as dominated by independent faculty baronies, preoccupied with scholarly excellence, that remain unconcerned with the industrial impact of the ever-increasing rate of scientific advance and technological development, much of what may originate in the university. (p. 30)

The perceptions of researchers from both sectors seem to support what the writers above have written. Lawyers were indeed frequently mentioned as slowing the process. However, one of the lawyers who had been involved in some of the agreements blamed the University for the delay, noting the following regarding the time-factor problem:

> I think that is the pace of the university. It is a commercially unacceptable time frame, but the university operates on such a democratic basis with so many entities having to approve these kinds of external relationships. That is one of the problems. . . . When you go through these approval processes, there are so many bodies that have autonomy, that are independent, that have vetoes, so it seems nobody has the power to get things done; everybody has the power to stop it.

Thus, although the respondents seemed to be content with the policies and procedures governing university interactions on research and development, they were concerned with the slow decision-making process. Some suggested the examination of

another model to emulate might be the way to go. In fact, a few mentioned the external agent model referred to in Chapter 2 as perhaps a better model than having the liaison office as part of the University's administrative structure. This is because if the liaison office is external and autonomous, the officers should be able to make quicker decisions rather than having to refer them to higher authorities for approval and action. On the other hand, some respondents felt that even the in-house model can be efficient if the office is given the authority to make decisions without having to refer them to higher authorities for approval.

Stankiewicz (1986) referred to a 1982 Stockholm Workshop that made a number of recommendations about university-industry liaison offices. One of these was that those units should be located within the university structure so that the offices become intimately familiar with the departments and their activities. Some university administrators made it clear that they supported the in-house model, which in essence is the current structure. Referring to the external model as the "arm's-length" model, a senior administrator noted that adopting this model (the arm's-length model) implies that the university is not comfortable with university-industry partnerships as part of its mission, and therefore those who support the model reason that

> we should not have this going on as part of our mission. We should set something up that's arm's length, and we should have a company that the university owns but is separate and autonomous from the university, and that becomes their industrial liaison office with their technology transfer and commercialization techniques. So if anything goes wrong, we won't be in trouble.

The administrator further noted that university-industry partnerships should be regarded as part of the university's mission:

> We are in the business of discovering and disseminating knowledge. We have traditionally disseminated it through journals and publications. We need to think of industrial partnering as part of our academic mission, not separate from it, but part of it.

The Director of the Intellectual Property and Contracts Office, in supporting the

internal model, stated:

> I think that university-industry liaison should be an integral part of the academic program so that you can use the university-industry connection as a means for university development as a means for developing better linkages such as supporting research, providing projects for students, providing funding to expand research. All these things I think are better done when it is an integral part of the academic program. If you make it just a for-profit organization, you will not capitalize on the many opportunities that are present.

Some of the respondents as has been noted in Chapters 5 and 6, in complaining about the university bureaucracy, called for a reorganization of IPCO, whereas others felt that it should be given more autonomy. Although the University has chosen to retain the internal model, and with the hiring of a new director, it still remains to be seen whether the complaints raised by researchers will be addressed. It is interesting to note that in the past a great deal of interest and focus has been on the Office of Research Services. The President's Advisory Committee on Campus Reviews (PACCR) review of the office in 1989 recommended changes to the office. This eventually led to the creation of Research Grants Office and the Intellectual Property and Contracts Office. The 1992 University of Alberta Task Force mentioned earlier and established to examine the implications of two national reports on the University recommended a reexamination of which models of liaison office should be adopted for university-industry activities. Yet the key questions still remain: Should the focus be on the people or the structure? Are people perhaps being blamed for an inappropriate structural arrangement and ineffective procedures and policies?

Overhead Costs

As was noted earlier, some respondents from both sectors felt that the 40% overhead charges were too high, whereas others felt that the rate should not be fixed but should depend on the nature of the project undertaken. It was also reported earlier that a subcommittee of the University Research Policy Committee had been appointed to look into the whole issue of overhead costs. What the committee found was that the 40% charge was within the range charged by other universities. Some have argued that the overhead

charge is very low compared with what professional consultants would charge for undertaking such work. Industry is not totally opposed to overheads but to the way in which they are determined, so it would seem that this is something that the two sides can discuss and on which they, hopefully, could agree. There is no evidence that industry has been asked for any input into this matter. This is perhaps an approach that could be adopted.

It will be noted, though, that some industries have opted to have grant research agreements rather than contract research agreements because overheads for grants are less than those for contracts. Despite the complaints raised by some interviewees on this issue, the 1994 University policy on overhead costs provides a clause for flexibility in charging these costs which states that "while the indirect recovery rates are standard, the administration of the policy is flexible to cope with the peculiar nature of individual situations" (p. 6-1-6). However, given the views expressed by industry respondents, it would seem that this flexibility is rarely provided.

Indeed, overheads have been and will continue to be a contentious issue. Carboni (1992) called it "a vexing issue" stating that "limited understanding or interest in these costs and occasional university excesses have made these levies a constant source of irritation for faculty investigators and government and industry sponsors" (p. 58). Barrington (1993) noted that "the level of overheads is one of today's 'hottest potatoes' in university research" (p. 442) but supported the charging of these overheads on a case by case basis, a suggestion which was offered earlier by some of the interviewees in this study.

Pressure Felt by Small Companies

Small firms, it was noted, felt the pressure of competing with large firms for university expertise. They were unable to offer the large amount of money that large companies can. One industry respondent, however, reported that they used the university expertise to provide their company with some leverage with the competition. It cannot be established that university researchers prefer to go to larger companies for research

contracts rather than to small companies, but this is an area that needs to be examined further. NSERC has university-industry programs geared to small companies, as was noted in Chapter 4, but the extent to which these NSERC programs have been utilized by the universities and the small companies is unknown.

Conflict-of-Interest Regulations

Conflict of interest appears to be area that continues to generate a great deal of debate in university-industry research. It was apparent that conflict of interest is one of the reasons given by opponents of university-industry research to support their contentions. In Chapter 4 the university policies and regulations governing university-industry relationships in research and development were outlined. Although most respondents from both sectors were satisfied with these policies and regulations as noted in Chapters 5 and 6, it was noted that there were also some from both sectors who felt that the regulations governing conflict of interest were too strict. Because the policies allowed the faculties to establish further detailed regulations based on university policies, there was a feeling that conflict-of-interest regulations differed from one faculty to another, and thus some were more restrictive than others. An industry administrator who also held a teaching position, in reference to conflict of interest, commented on past misconceptions about university-industry research:

> There was really a lack of understanding of the process, and a lot of people in academia—and this is quite common—see industry as a sort of dirty shirt and that you have to be careful when dealing with industry. This is not criticizing my colleagues, because it is a common perception, and ... you have all these skeletons in the closet and words like *conflict of interest* and things like that. When people don't really know what they mean, they cite the term *conflict of interest* in order to express a concern. So I have asked my colleagues: "Well, what do you mean by conflict of interest?" and in most cases they really can't [tell me]. I think the concerns are on both sides, the university and industry, and they are valid concerns. I think there has been a lot more communication back and forth so that each side sort of understands the other.

There was evidence of interest to keep reexamining problems in this area. The Faculty of Medicine university-industry working group noted in one of its 1993 meetings

that conflict-of-interest guidelines should cover clinical trials as well (Minutes of May, 1993 Meeting of Faculty of Medicine University-Industry Working Group p.1). Further, one researcher from the Faculty of Medicine noted that a faculty member who owned shares in a spin-off company could not be allowed to receive contract research funds from the same company. He noted that this was problematic for those who started spin-off companies and still wanted to continue teaching. An examination of the Faculty's guidelines, however, provides an exception to this rule through approval of the Department Chairman, the Dean, and the Vice-President (Research) (*Guidelines for University-Industry Relationships - Faculty of Medicine*, p. 10). Newson and Buchbinder (1980, p. 368) noted that academic senates (General Faculties Councils) have rarely been involved in deliberations on university-industry collaborations. Findings from this study, however, suggest the contrary. The faculties have been involved at least, as we have seen, in formulating guidelines governing these research links. The General Faculties Councils has been involved in formulating policies governing research with industry, and these policies were forwarded and approved by the Board of Governors. Whereas the faculties may not have been involved in every research agreement (which would contribute further to the university bureaucracy criticism !), at least respective heads of departments or deans are always involved in the sense that they give approval as well. The only limitation seems to be that, although the University and the faculties acknowledge that there are academics who are opposed to these links, their opposition was not evident in any of the documents examined such as the minutes of meetings of the General Faculties Council and the Board of Governors. It was noted by one university researcher, however, that Faculty Councils and the General Faculties Council are the appropriate forums for opponents of these links to express their views and concerns. The minutes of the Faculty councils were, however, not examined for this study. Conflict of interest it seems will continue to feature in these relationships, and it is important that it be appropriately addressed.

Reward Structures for Participants in University-Industry Research

Most of the criticism of reward structures came from industry respondents. The contention was that the motivation of academics is exploration of knowledge and publication of research results, and not commercialization; and, further, that this is reinforced by promotion and tenure practices which encourage publication. Respondents noted that university and government policies seem to encourage this. Examples of this were provided in Chapters 5 and 6. One involved situations where researchers with industry research experience were not well favored for promotions because they had not been peer reviewed through publications. The other example given was funding from NSERC which encouraged publication. One industry respondent claimed that

> universities are not structured in a way that encourages these academics to get involved in industrial liaisons of any kind. They have a reward system that rewards, by and large, the generation of papers. These papers are funded largely by NSERC. The more papers they write, the more money they get from NSERC, and they build a machine that perpetuates that.

However, the 1994 NSERC document referred to earlier, *Partnership in Knowledge: Maximizing the Investment in University Research,* acknowledged this limitation when it stated:

> NSERC recognizes that university reward systems, especially for tenure and promotion, may have limiting impact on the activities undertaken by faculty researchers. The Council will encourage universities to give more recognition to outreach activities such as interaction with industry and professional associations" (p. 10).

A senior university administrator interviewee acknowledged the same problem:

> One of the problems has been, we have one of the largest professoriates in the country, but our record has not been very good. Why? Nobody is disclosing anything; nobody is bringing forward their ideas ... there is no reinforcement for it. They aren't sure that it is going to be considered to be legitimate. So what we are saying now to the professoriate is, "There isn't a conflict here. We will look after your conflict if there is a conflict. If you have a discovery or an idea, it is as important to express it to industry as it is to write it up in a professional journal."

It is evident that this reward structure for involvement in university-industry research is receiving attention by both the university and the funding agencies such as

NSERC. To what extent this reward structure is being addressed can be known only through a survey of a large population of those researchers involved in these uiversity-industry research links, an endeavor which was beyond the scope of the current study.

Academic Freedom and Industry Research

There was a great deal of emphasis in the literature on the problem of involvement in industry research leading to a loss of the academic freedom in universities and a loss of publication rights (Fairweather, 1988, pp. 9, 47; Matthews & Norgaard, 1984, p. 37; Melchiori, 1983, p. 11). All the university interviewees pointed out that they would not accept industry-driven research. What they did was to respond to the challenge to solve industry problems, and they did not consider this as caving in to industry interests. As one researcher noted:

> We refused to pursue a goal-oriented contract. If people have a chance to look at our research contracts with two companies, so-called industrial funding, they will discover that we had very strong statements in there that we only wish to do basic research; we don't wish to be told what to do by the company, because that is not in the best interests of our activities in universities.

None of the university researchers mentioned that they had ever had any problems with the publication of their industry research. In fact, some had published jointly with industry researchers with whom they collaborated. It will be noted, of course, that interviewees from both sectors supported the current university policies which lay down all the regulations governing university-industry research. The feeling was, therefore, that the time given for the patenting of research results before publication, which is a maximum of 18 months after the production of research results, is acceptable to both parties. Matthews and Norgaard (1984, p. 186) cited examples of cases where professional journals have delayed publication for longer periods than the period of delay required by the research sponsors.

Challenges and Insights

Interviewees commented on some of the lessons learned and insights that they had gained from their participation in university-industry research partnerships.

Importance of Researcher-to-Researcher Interaction

Respondents from both sectors noted that researcher to researcher interaction is often overlooked and emphasized that it is critical to the success of these research interactions. Interaction between scientists in both sectors was very much emphasized in the literature on university-industry partnerships. Matthews and Norgaard (1984) noted that "even when partnerships are initiated from the top down through leadership of a highly placed individual, their success often depends upon an established and effective network among scientists" (p. 166). A report of one faculty's experience in staging a conference between university scientists and industry executives found that there was a gap in the level of interactions between them and recommended that at the next meeting they should invite "medical or scientific directors of companies [because] they would be better equipped to evaluate the science than were the CEOs" at the previous meeting. The report noted that "it was extremely important to nurture scientist-to-scientist contacts." This experience supports what Levinson (cited in Matthews and Norgaard, 1984, p. 163) emphasized: that the effectiveness of meetings between representatives from industry and higher education will depend not only on the specific agenda, but also on the kind of personnel invited. He pointed out that individual researchers need to share information with their counterparts in industry or higher education.

Importance of the "Champion of the Project"

One of the important roles emphasized by both sectors is that of having a "champion of the project" in industry. This person would be the mover, the coordinator, who would be committed to the project and would act as the liaison between the university

researcher and the company regarding the project. From the experiences of interviewees in both sectors, whenever there has been a "project champion," the project results have been a success. This project champion would be somebody knowledgeable in the field (scientist, engineer, etc.). The successful role of the project champion was documented in the literature (Russo & Herrenkohl, 1990; Schon, 1963; Smith et al., 1984). Referring to the writings of Smith and associates (1984)., Russo and Herrenkohl (1990) noted that "the existence of a strong proponent within the company who is willing to actively sell the research to upper management" is an important factor in technology implementation (p. 22). Schon (1983) noted that this champion "must have a great deal of power and prestige in the organization as well as knowledge of the formal and informal system of communication" and should have "wide interests that cut across the special interests including technology, marketing, production, and finance" (p.34). Indeed, some companies had such personnel, whereas others that did not have indicated interest in having them:

> If we want a specific project ... to be performed at the university, we have got to be constantly in touch, and to do that we have got to allocate somebody who is a champion of that project and is in constant touch [with the university] and has to have time allowed to do this. If there are some ideas from our end he can convey them ... he should get the results from the university and report to us. Somebody has to do it, and if left blank, then nobody really makes it a priority.

Indeed, this kind of person would ensure that the project is kept on track and that the level of interaction between the two sectors is high, an element that was emphasized also by the participants.

Keep Interaction Levels High

Respondents mentioned constant communication as critical to the success of the partnerships. This is precisely the reason for having a project champion in industry: to ensure that this level of interaction is maintained. As one respondent pointed out, "this is what collaboration is about: It is about ongoing dialogue."

Appreciation of the Quality of Science in University and Industry

In Chapters 5 and 6 it was pointed out that there was a recognition by respondents from both sectors of the high quality of science in the university and in industry. Whereas in the past, university researchers considered industry scientists as "second rate," the experiences of the participants indicated that they had learnt that "many of the industry's scientists are first class." On the other hand, industry participants reported that through participating in these partnerships, they had realized that universities had a tremendous amount of expertise and potential which was not being fully exploited by industry. Some University respondents, in particular, pointed out that it was for the quality of science and scientists that industry sought research and development partnerships. This, therefore, has implications for science programs in the universities.

Applied Versus Fundamental Research: Emphasis on Integration

One of the findings of this study is the importance which industries attach to fundamental research. Industry respondents pointed out that it is mainly because of fundamental research that they seek collaboration with the universities. As one explained:

> We feel universities have a role in terms of technology invention and fundamental knowledge development.... [provoding and doing] fundamental science in a far better way than probably we are positioned [to do] at present. I think the environment at the university is one where you have the freedom to explore. Fundamental research is not our main objective.

Yet some of the literature cited these kinds of collaborations as detrimental to fundamental or basic research in universities and expressed the fear that more funding and emphasis would be on applied research at the expense of basic research (Bok, 1982, p.152; Buchbinder & Newson, 1990, p. 371; Wasser, 1990, p. 112). This study seems to confirm other recent studies that reported that there is no basis for the claim that fundamental research has suffered as a result of these university research and development relationships with industry (Philips, 1991, p. 484).

What Should Be Done to Enhance University-Industry Partnerships in Research and Development?

The respondents addressed the questions concerning what should be done to enhance the partnerships, and what challenges needed to be overcome.

Fostering Positive Attitudes

The need to foster positive attitudes between universities and industry was stressed by respondents from both sectors. Because there were still people in industry who considered universities as ivory towers, it was necessary to change this mentality through providing research and development services to industry that industry would appreciate. Even within the university, as one administrator noted, the faculty members have to be encouraged to view involvement in university-industry research as "a legitimate, viable form of dissemination of knowledge." Some of the faculties had already taken a number of initiatives to hold conferences and seminars involving both university researchers and industry personnel in order to bring greater understanding and appreciation between the two sectors.

Marketing by Both Sectors

Marketing of research capabilities is an area that all respondents from the university and industry sectors emphasized as important. From the industry perspective the problem was always "We do not know what the universities have to offer." Similar sentiments were expressed with regard to industry: "What can it do for the university?" One industry respondent perhaps summed it up best:

> The University doesn't sell itself very well; it sort of expects people to know that it is wonderful. Industry doesn't sell itself very well in terms of what it can do for the institution or what it needs from the institution.

One industry respondent complained that the university should find out what the industry needs are and work to meet those needs rather than merely selling to industry ideas

and technologies already developed. This perspective is tied to what in the literature on technology transfer was referred to as "technology pull" and "technology push" (Maguire & Kench, 1981). Technology pull is the situation where the innovator responds to the needs of the user and designs technology according to the user's demand, whereas technology push refers to the innovator's selling the developed technology to the user without due regard to the user's needs. Lambright (1976) suggested that the ideal situation should be a balance between the push from the innovator and the pull from the user. Fassan (1991) observed that "marketing has been introduced to the university rather late in the day. Marketing of science is a recent phenomenon and has not received a very broad dissemination as yet" (p. 541).

As was noted earlier, IPCO was expected to market university technologies, and yet this is a role that university respondents did not seem to think the office was fulfilling well. On the other hand, there were a few respondents from industry who acknowledged the efforts that IPCO was making in this regard. It was noted that the University of Alberta had a number of new inventions. One industry administrator stated:

> These have to be taken and shown to the world in case somebody needs one. It is being addressed now. The Intellectual Property and Contracts Office is moving in the right direction for this. But this has certainly been a challenge.

Industry respondents did not specify how this marketing would be done. As for the university sector, although it is clearly specified that IPCO should market university technologies, it is not clear how they do it and to what extent the researchers should be involved in marketing their ideas and expertise. IPCO produces a number of brochures on different research areas at the University, but it is not clear how these are distributed to the various industries. The Office of the Vice-President (Research) recently issued a document, *Making Sense of Research at the University of Alberta* (1994) which outlined areas of research excellence at the University. Whether this is an adequate way to market part of its research program remains to be seen.

Enhanced Research Excellence at the University

Some University respondents noted that it was because of the quality of research at the university that companies were attracted to research and development partnerships. It was important therefore that efforts be made to enhance and maintain research excellence through attracting highly qualified personnel and providing a conducive environment for such partnerships. The technology pull described earlier would then be possible. Gee (1993, p. 656) emphasized the high quality of faculty and research programs as well as willingness to work with industry as one of the essential ingredients of an effective cooperative research and technology transfer from university to industry.

Structural changes

Most of the comments regarding structure dealt with the decision-making process and the reward structures. Respondents from both sectors called for quicker decision-making processes and delegating authority to action offices. With regard to reward structures, the consensus was that promotion and tenure policies of the university should recognize university-industry research involvement as valid as publications, and other scholarly production.

Planning the Need for a Coordinated Approach to Partnerships

Some respondents identified the need to have a strategic plan that would outline strategies for the technology-transfer process to industry. Others pointed out that there was a lack of a systematic effort by the government, universities, and industry in university-industry partnerships and called for a coordinated approach to research and development partnerships, especially with regard to policies and their impact on these relationships.

Although the university has over the years enunciated its support for university-industry partnerships, there has not been any strategic plan to address this area. The University's latest strategic plan, *Degrees of Freedom: A Strategic Plan for the University*

of Alberta to the Year 2005 (1993), emphasized the need to serve society. The document states:

> Our mission may be furthered through such activities as promoting culture, stimulating technology transfer, strengthening the global economy through basic and applied research, and providing highly trained personnel to serve not only Alberta but Canada and the world as well. (p. 13)

How this is to be translated into actual practice is not clear—whether the university will have a blueprint or will leave it to the faculties. Given recent initiatives by faculties to interest the private sector in their teaching and research programs, it would seem that perhaps that is where the focus of planning efforts should be centered.

As for the coordinated approach involving the three sectors—government, universities, and industry—it was pointed out that this has been lacking and that often policies and actions in different government departments seem to be contradictory; thus the call for a coordinated approach. The establishment in September 1994 of Alberta Science and Research Authority seems to be a response to this concern. A Government of Alberta summary statement released on September 15, 1994 outlined the mandate of of this Authority. One of this stated:

> Through consultation with the private sector, other departments and government agencies, and the research community, the Authority will set the government's long-term and short term goals for research and development in Alberta. These goals will provide the basis for a strategic plan to address priority needs, capitalize on emerging opportunities, integrate complementary programs, agencies, and other initiatives, and maximize the overall effectiveness and efficiency of research funding. (p.2)

The government statement further pointed out that the Authority will "advise on and coordinate federal/provincial and interprovincial science and research programs and initiatives" (p. 3) and "will also work closely with Alberta's university based research community to identify opportunities for enhanced cooodination and collaboration in applied research and technology commercialization areas of mutual interest" (p.6). Indeed, the membership of the Board of Management for this Authority has university and industry

representation as well as government members. Although its impact is yet to be felt, this appears to be a step in the right direction.

Summary

This chapter has provided an analysis and discussion on the perceptions of university and industry respondents on university-industry partnerships. Their perceptions were examined in the light of the literature on these research and development partnerships and on interorganizational relationships. The level of awareness concerning what each sector (university or industry) could offer the other is very important in enabling the respective organizations and individuals to decide whether to establish partnerships or not. This awareness relates to what physical resources the organization has to offer to the other and to the personnel resources that exist within those organizations. This is why all the participants stressed the importance of marketing their resources by both universities and industries and the need to explain what they can offer each other. Marketing would, therefore, enhance the level of awareness and facilitate decision-making with respect to the establishment of research and development partnerships.

The factors motivating the establishment of these research and development partnerships are consistent with those reported in the literature on other research and development partnerships. However, the driving factor concerned with whetting the intellectual curiosity of the university researchers was very much emphasized over the financial factor. Whereas the literature and critics of research and development partnerships seemed to emphasize the money element, this study found that university researchers valued the intellectual curiosity of the project, and in fact some of the university researchers stated that they did not welcome directed research by industry. On the industry side, the search for university expertise was stressed as the prime reason for seeking R & D partnerships. However, the support by some industry respondents of the value of fundamental research at the university and the fact that they did not wish to see this kind of

research weakened was a departure from popular belief and emphasis in the literature by university-industry critics that these research and development partnerships weaken fundamental or basic research.

Structures for partnerships came under a great deal of criticism from the respondents, and this is consistent with the criticism found in the literature. There was evidence that this is an area with which the university is grappling, specifically, how best to provide suitable and effective structures and processes. The issue of who should play the boundary spanning role and to what extent boundary spanning should be done is an important one. Respondents from both sectors supported the university policies governing these partnerships but were dissatisfied with the overhead policies. The problems perceived to affect these partnerships were discussed and found to be consistent with those expressed in the literature on partnerships. However, it was found that issue of intellectual property, which is often mentioned in the literature, appears manageable and not a source of any major problems. Issues of university autonomy and academic freedom which are also mentioned in the literature as threats facing those involved in the partnerships were found not be major issues of concern in the current study. The reward structures for those involved in these partnerships were found to be inadequate and needed to be addressed. Insights gained by the participants were also identified. The importance of researcher-to-researcher interaction and the presence of project champions in industry who would ensure the follow-up on the research project and maintain constant communication between the university researchers and industry were considered key elements for success. Finally, recommendations for possible strategies to enhance these partnerships were provided. These include marketing and the encouragement of positive attitudes by both sectors.

CHAPTER 9

SUMMARY, CONCLUSIONS, IMPLICATIONS, AND REFLECTIONS

This chapter provides a summary of the study. The first section outlines the purpose of the study and describes the design and methodology adopted. The second section is a summary of the findings and conclusions of the study. The third and final section contains the implications for practice, the recommendations for further research, and the researcher's personal reflections on the research.

Outline of the Study

This section provides the outline of the study. The purpose of the study and the research questions that guided the study as well as a summary of the research design and methodology adopted are summarized.

Purpose of the Study

The general purpose of the study was to develop an understanding of university-industry research and development partnerships, as these are specifically manifested between the University of Alberta and industry, by exploring, describing, and explaining the structures, processes, problems, and challenges that these partnerships face.

The following questions guided the study:

1) What R & D partnerships exist, and what forms did they take?
2) Why were they established (motivations) and how were they established?
3) How are they organized and managed?
4) What benefits have been derived from these partnerships?
5) What problems and challenges have they faced from the initiation to operational stages?
6) What insights have been gained by those involved in these research and development partnerships?

7) How can these partnerships be enhanced?

Research Design and Methodology

The study was conducted in the interpretive paradigm and utilized a case study approach focusing on the initiation, structures and processes, problems, and challenges of research and development partnerships between the University of Alberta and industry. Two main data-collection techniques were utilized: documentary reviews and analysis and 40 interviews with those involved in the partnerships from both the University and industry sectors. A review of the relevant literature guided the researcher in developing a background understanding of university-industry partnerships and helped in the development of the semi-structured interview guide. Purposive sampling was used in identifying potential interviewees. The interviews were tape-recorded and then transcribed. The transcriptions were returned to the interviewees for confirmation, thus ensuring the trustworthiness of the data. The data from the interviews and review of documents were processed and analyzed by coding, categorizing, and critical assessment vis-à-vis the conceptual framework and the existent literature. A number of general findings were thus obtained.

Summary of Findings and Conclusions

In this section a summary of the findings and conclusions derived from the study are provided.

The University's Position on Partnerships

A review of documentation and minutes of meetings of the University's Board of Governors indicated that the University of Alberta began to manifest a greater interest in university-industry collaboration with the establishment of the Office of the Vice-President (Research) in 1981 and the Office of Research Services in 1983 to develop closer links with the private sector (Board of Governors Report, 1982/83, p. 9). A review of the minutes of meetings of the Board of Governors from then to date revealed continuing

revisits to and discussion of matters related to enhancing university-industry collaboration for technology transfer purposes. Recognition of the challenges posed by university-industry contracts was made by the Vice-President (Research) in 1982. As a result, policies were developed by the University that helped to guide university-industry interactions. These policies cover such areas as patents, intellectual property, royalty sharing, conflict of interest, overhead costs, and publications, to name only a few. These policies have indeed helped to guide faculty members involved in these partnerships. Some of the respondents commented on the difficulties they had in earlier days when policies on university-industry linkages did not exist and were formulated as these research and development linkages with industry developed. The establishment of other offices such as the Intellectual Property and Contracts Office in 1990 provided further evidence of the university's intention to strengthen research and development collaboration with industry.

The Forms of R & D Partnerships

University-industry research and development partnerships were formed through the following mechanisms: (a) research grants, (b) research contracts, (c) institutes and centres, (d) networks of centres of excellence, (e) affiliation agreements with companies and centres, (f) consortia, and (g) industrial chairs and fellowships. The first two of these mechanisms, research grants and research contracts, were found to be the predominant modes of collaboration with the private sector in research and development.

Characteristics of Industries Linked to the University

The companies that had research and development research agreements with the University through contracts and grants ranged from small firms to large corporations.

Location of companies. As was noted in Chapter 4, about 80% of the companies having research links with the university were Canadian and 20% were foreign. However, the distribution differed when examined by faculty. In general, there were more companies from outside the province of Alberta that had research links with the University

than from within the province. The only exception to this was the Faculty of Engineering, where the majority of the linking research and development companies were from Alberta. Further, the Faculty of Engineering was the only Faculty among the four Faculties that had no research and development links with foreign companies. This was attributed to the nature of the resource base of Alberta, which is basically agriculture and energy. Most of the other Canadian companies that had links with the Faculties of Science, Medicine, and Pharmacy were based in eastern and central Canada. The reason given for this was that these areas are where medical and biotechnology industries are well developed and established.

Motivating Factors for Involvement in University-Industry R & D Partnerships.

University interviewees gave the following reasons for their participation in industrial research. First, such involvement provided a source of funding for their research projects and for upgrading laboratory facilities and equipment, as well as for supporting graduate students. Some of the university respondents noted that they were not involved in the partnerships to make money but cited the need to upgrade lab equipment as one of the reasons. They reported that graduate students benefited by doing research that had practical relevance to industry and that the motivation of graduate students was higher when they were involved in research that had practical relevance. Further, it was noted that graduate-student involvement in some of these research and development projects often led to their being offered employment in the same companies for which they did their research.

Industry, on the other hand, saw funding of university research projects as an investment from which they would eventually benefit through the commercialization of research outcomes. A number of interviewees from both sectors, however, emphasized that industry funding and any revenues from research and development ventures would not be a substitute for government funding because the percentage of revenue for support of research from industrial sources was still insignificant.

The second motivator for participating in university-industry research was that extra funding would enable these researchers to do more research than they would otherwise have been able to do. Some researchers used such terms as "whetting their *intellectual curiosity;* others wanted to "pursue the research of [their] dreams." Given the government cutbacks, this type of involvement was considered a necessity. However, the underlying emphasis here was that the quest to do research was paramount over pecuniary benefits that might accrue from such involvement. Interviewees contended, therefore, that research was part of their mission.

For some, their research efforts had reached a stage where their research findings needed further development in order for commercialization of the products of their research to be achieved, which the current funding arrangements would not allow. They felt that they had to seek an industrial sponsor willing to fund further development for this purpose.

For others, doing industry research accorded them the opportunity to engage in applied research, that is, to translate some of the fundamental research ideas for application. For some involvement in industry research led to the enhancement of academic profiles.

What Benefits Have Been Derived From These Partnerships?

Related to motivational factors are the benefits that participants in research and development partnerships derived. Four kinds of benefits reported were similar to the above motivators: (a) funding for professor's research and upgrading research equipment, (b) funding for graduate students, (c) enhancement of employment opportunities for graduate students, and (d) satisfaction derived from engaging in research and development activities (salving their curiosity and thirst for knowledge). In addition, a fifth benefit was identified by university researchers: providing industrial research examples that enriched their teaching.

What Problems and Challenges Have These Partnerships Faced?

All respondents reported that they encountered a number of problems as a result of participation in such partnerships. Although some problems were similar between the two sectors, others were unique to university or industry environments.

Respondents from both sectors acknowledged that negative attitudes towards those in the other sector still existed. There were still traces of the "ivory-tower" concept of the university in industry and a mistrust of industry by some in the university community. Respondents acknowledged, however, that, based on their experiences over the years, there had been improvements in attitudes in both sectors. Further, there were also within each sector those who did not see university-industry research and development partnerships as important or as a priority. Whereas researchers in the University had to work in an environment where some of their colleagues did not support these ventures, those in industry who supported these links were faced with threats of reduction in research and development funding because some of their colleagues did not consider research and development links with universities as a priority.

Respondents from both sectors noted that the time taken to finalize research contract or grant agreements was too long. This normally occurred in situations where agreements between the particular parties were being made for the first time. Related to the matter of time to finalize the agreements was the assertion by industry respondents that University researchers place an unrealistically high value on their ideas, and thus issues of intellectual property consumed a great deal of time in negotiating with industrial partners. It was noted, however, that in subsequent agreements between the same parties, whether it was a renewal of the same agreements or initiation of new ones on more or less the same terms, the process was much easier and less time consuming.

Some industry respondents identified a lack of focus on the research program initially agreed on in the research agreements and thus leading to the program "drifting away from the original intent" as one industry respondent put it. This was attributed

mainly to a lack of frequent communication between the parties, with the result that the issue seemed forgotten until the university professor was, in the words of one industry, "rattled in his cage!", that is reminded to provide an update of the progress of the research project.

University bureaucracy was considered by some respondents from both sectors as a stumbling block which slowed the pace of activities involving research and development partnerships. This was especially so with regard to negotiating the research agreements and initiating the terms of the agreements. Most respondents pointed out the different layers of administration that had to approve these agreements, noting that this slowed down the process and led to long delays. They recommended, therefore, that the decision-making processes be shortened and that the delegation of authority to handle partnership issues be given to the offices handling them.

Overhead charges were considered a contentious issue by respondents from both sectors. Some thought that they were too high, and others were dissatisfied with the formula used to determine the rates charged. Some university researchers noted that there was no accountability as to how these funds were spent, and others feared that industry might be discouraged from funding research and development projects given these large overhead costs.

Respondents from Small companies cited the problem they faced in competing for university researchers with large companies that had ample resources. They did not have adequate resources to do this. The extent to which university researchers look for large-scale funding from large firms in preference to small companies is not clear. Nevertheless, it was evident that the small companies felt disadvantaged in this respect.

University research structures were another area considered by respondents from both sectors as an obstacle to university researchers' participation in partnerships with industry. It was noted by respondents from both sectors that tenure and promotion decisions were based more on research publications rather than on other research activities

such as involvement in university-industry research. This practice, the respondents claimed, acted as a disincentive to involvement in industry sponsored research.

What Is the Nature of the Environment of University-Industry Linkages?

University policies. Respondents from both sectors lauded university policies governing university-industry research and development partnerships. The only policy that received mixed reactions was the policy on overhead costs charged to research sponsors.

Government policies. Federal-government programs that encourage collaborative research and development projects between the universities and industry were also praised. The NSERC and MRC university-industry programs were identified as beneficial, as were IRAP and Alberta's AHFMR programs. However, the abolition of matching grants by the provincial government was criticized.

Operational environments. Respondents from both sectors generally described the environment as good and that it was improving. Although it was acknowledged that there was still an element of suspicion between the two sectors, there was a general feeling that the attitudes of those in the other sector had improved over time.

What Insights Did the Participants Gain From Their Research and Development Partnership Experiences?

Perhaps the most important insight reported by the respondents in this study was that researcher-to-researcher interaction is vital. Respondents from both sectors pointed out that, from their experiences, promotion of more researcher-to-researcher or scientist-to-scientist interaction was the most effective means of enhancing research and development partnerships. This approach was supported by the literature on university-industry partnerships. In fact, even when university scientists and industry CEOs met in those faculties that had initiated such sessions, these sessions were not very successful because the CEOs did not fully understand the language of the scientists.

A related insight is that a project champion within the particular industry supporting the project is a key element to the success of research and development partnerships. As was noted in Chapter 5, the experiences of the participants, especially those from industry, were that quite often following the signing of a research agreement between the university and the company, the university researcher was left to pursue the research project. Because of other pressures, the project was almost forgotten by industry sponsor, and the university researcher may not have communicated with the industry on the progress of the project. Some companies, therefore, decided to appoint a representative (preferably a scientist or engineer) who would be in charge of the project and who would be in constant touch with the university researcher to provide industry management with regular updates and any requests needed to ensure that the project was successful. This idea of having a "project champion" or "product champion" in industry to serve this linking function was regarded as one of the most important lessons learned by respondents from both sectors.

Constant interaction and dialogue are a necessity for partnerships. Respondents emphasized the need to keep the levels of interaction between the two sectors high. This, they noted, was the essence of partnerships. It was noted that signing contract agreements and waiting for the results were not enough; this was not in the spirit of partnerships. Respondents felt that when higher levels of interaction were maintained, the benefits were greater.

There was recognition of unexplored talents and resources in both sectors. The participants realized that there was a tremendous potential that could be exploited in both sectors. The quality of science in industry was one of the areas that in the past had been derided by university researchers. However, the university researchers involved in research and development partnerships in industry reported that, from these experiences, they had learnt that the quality of science in industry was very high and that "many of industry's scientists are first class." These experiences seemed to have created better attitudes towards each other in both sectors.

Fundamental research was, perhaps surprisingly, recognized by some industry respondents as vital to industry. The notion that university-industry partnerships would affect the level of fundamental research at the universities because more focus would be placed on applied research was common in the literature on these partnerships. However, in this study a number of industry respondents noted that, from their experiences, they had found that fundamental research was critical to their industries, and it was the very reason that they had sought collaboration with universities—because universities were better placed to do fundamental research than is possible in an industrial setting. For these industry respondents, then, fundamental research was an important element of university research and development partnerships.

How Can These Partnerships Be Enhanced?

Respondents from both sectors emphasized the need to foster positive attitudes towards one another. This was important in order to change the old stereotypes of universities as "ivory-tower" havens and industry as "cash grabbers." A change of attitude would pave the way for more dialogue and hence more collaboration, not only in research and development, but in other areas as well, such as teaching and training.

A second suggestion arising from the study related to enhancing research and development partnerships is that both sectors should conduct aggressive marketing. Marketing was another line of action unanimously recommended by respondents from both sectors. Respondents acknowledged that neither sector had done a good job informing the other about their products and capabilities, from which both sectors could benefit. It was noted in chapters 2 and 8, for instance, that the level of awareness was an important factor in the initiation of partnerships between organizations. Increased information sharing would not only enhance this level of awareness, but in cases where there were particular technologies or related resources to be marketed, it would also lead to more research and development partnerships between the two sectors. It was observed, for example, that some of the faculties had already initiated promotional sessions where they displayed some

of the research programs and developments in which their faculty members were involved and in which industry was invited to participate. The Office of the Vice-President (Research) has also organized a yearly event normally called "Research Revelations" in which faculty members display their research work—either interdisciplinary research or a focus on a particular subject area of study. In this exposition students, members of faculty, and members of the public, including industry, are invited to attend.

Regarding what the university should market, some respondents from industry identified the need for universities to respond to industry needs; that is, to find out what industry problems and needs exist, and then to respond to them in their research programs, an approach described in the literature as "technology pull". This strategy was favoured by these respondents rather than initiating technologies and only then seeking to interest industry in these new technologies. The latter is described in the literature as "technology push". The marketing responsibility, although clearly assigned to IPCO, appears to be an area that the University has yet to delineate.

To enhance university-industry collaborative research potential, it is apparent that every effort should be made to maintain the high quality of and even to improve University research programs. Because it was the quality of research and the calibre of researchers that attracted industry to seek research and development partnerships with the University, it was imperative that the quality of research be strengthened and that the environment be enhanced to attract high-calibre researchers.

Based on the criticisms voiced by the respondents, the amount of University bureaucracy should be decreased. Because of bureaucratic processes in University administrative procedures, many called for fewer layers of administrative decision-making and more delegation to officers responsible for handling university-industry research and development partnerships. A call was also made for reevaluation of the tenure and promotion criteria, with a view to making involvement in university-industry research and development partnerships an important criterion in making such tenure and promotion

decisions. This, some respondents felt, would encourage more faculty members to become involved in these research partnerships.

The final suggestion concerning how partnerships might be enhanced is that a coordinated, integrated approach to university-industry links be developed. The adoption of an integrated approach by the government (federal and provincial), the universities, and industry was one of the recommendations made to enhance research and development partnerships. Respondents observed that often government departments pursue policies that contradict one another and that this lack of coordination can hamper progress in research and development.

Implications for Practice

In this section, the implications of the study for those involved in university-industry partnerships are discussed. These range from the level of the researcher to the administrative and organizational levels of the universities and government.

Researcher-to-Researcher Interaction

As has already been noted, all interviewees underscored the importance of researcher-to-researcher interactions as key to the initiation and enhancement of university research and development partnerships. The literature on interorganizational relationships emphasizes the importance of an increased level of awareness at two levels: among administrators of organizations involved in interorganizational relationships and among the personnel at the operational level. In the context of university-industry research and development partnerships, this element of awareness and interaction exists at both levels. The interviewees' experience indicated that scientist-to-scientist interactions should be given more emphasis. Such interaction was also supported in the literature on university-industry partnerships. On the Canadian scene, the Higher Education Forum seems to focus on the interaction of executive administrators from both universities and industry. To what extent this body encourages interaction at the level of scientists is not clear. How might

scientist-to-scientist interaction between industry and university be enhanced? This seems to be the challenge for administrators and scientists from both sectors. Respondents in this study revealed that a number of faculties have already initiated ongoing dialogues between scientists from both sectors, and that the Office of the Vice-President (Research) was working in the same direction. This seems to be the approach to take. Similarly, it was noted that some industries had also taken the initiative to invite university researchers to visit their industry and give seminars on topics of interest to the company. Such endeavors will likely lead to further relationships. In general these types of university and industry initiatives seem to be the desired means for promoting researcher to researcher interactions.

Marketing: Who Should Do It?

Marketing of university inventions and potentials including research expertise and current research programs that might be of interest to industry was very much called for by industry respondents. These respondents noted the great potential in the universities of which many in industry were unaware. On the other hand, university respondents felt that they did not know what opportunities industries offered to them in research—what problems did industry want solved? Both sets of respondents suggested the importance of marketing by both sectors.

In the University studied, one of its policies clearly stated that one of the functions of the Intellectual Property and Contracts Office (now renamed Industry Liaison Office) was to "promote and market university technologies" (p. 3-4-2). Yet the impact of this marketing was not apparent for some in industry. Some industry respondents reported that they did not know who to approach when seeking research and development links with the University. The University has an Office of Public Affairs which also plays a public-relations role. It is not clear what role this office (Office of Public Affairs) would play in marketing the University and its research and development activities vis-à-vis the role of the Technology Management Officers (TMOs) at IPCO. Besides, there was the expectation that the best marketers for the technology inventions would be the researchers themselves.

As was noted in this study, some industry respondents felt that sometimes the language used by the researchers was too technical and needed to be simplified for certain of the industry audiences. The suggestion that University researchers, when trying to promote their research expertise, design and adapt their presentation strategies accordingly, would seem to be a good one.

A marketing strategy appears needed for universities desirous of strengthening university-industry research links. Michael (1991), in his study *Marketing higher education: Responding to a changing environment*, which examined marketing practices of higher education institutions in Alberta, noted that marketing was being practiced by these post-secondary institutions, although it was still at a low but increasing level "(p. 248). He suggested that because

> decisions are more diffused in a university with different units, departments, and faculties constantly making important decisions which have implications for the whole university, multiple marketing plans to cover different units may be more appropriate for a university than a unified marketing plan which may be more appropriate for a community college. (p. 248)

Whichever marketing strategy a university adopts, it seems important to note that this is an issue that needs to be given serious thought and action by university administrators and researchers. It should be noted, however, that calls for marketing were not only directed to the University but to industry as well. It should not appear, therefore, as if the onus of marketing is on the universities alone. Gamory (1988) quoted in Phillips, 1991) has expressed this position succinctly:

> ... 'pull' [by a company] consists of people who know what they need going out and looking for it-- and finding it--in a vast universe, rather than asking outsiders who don't know the company's situation to throw pieces at it. 'Pull' is much more likely to succeed moreover, because the burden of finding uses for research belongs not with the university but with the companies themselves. A strong science base ... cannot make up for inadequacies in the functioning of the development and manufacturing cycle[within companies]. (p. 487)

Both sectors should, therefore, strive to market themselves and seek each other in these collaborative research endeavors.

Revisiting Procedures and Regulations for Establishing University-Industry Partnerships

Interviewees from both sectors complained about the red tape in the initial stages of establishing research and development partnerships. In view of this, university administrators would be advised to re-examine the procedures that exist in their institutions for establishing research partnerships with a view to reducing the time taken to conclude these agreements.

Re-examining the Structures for Collaboration

Related to the above recommendation is the need to re-examine the current administrative structures for collaboration with industry on research and development. Some interviewees criticized the role played by the Intellectual Property and Contracts Office. Whereas some felt that this office was overstaffed, others considered it understaffed. There seems to be a trend to have more responsibilities transferred to the faculty deans' offices, with some officers from IPCO working more closely with deans of faculties. This is an area requiring further examination and has good potential for making a difference. However, there is a need to identify and assess the current shortcomings. It was evident from the interviews that some blamed the structure for the red tape, whereas others blamed the people performing the liaison roles. Where problems of this sort are evident, universities should determine the degree to which problems result from existing structures or are caused by the personnel involved. These would seem to be the necessary first steps to resolving such problems.

It is interesting to note that since the establishment of university-industry research and development links, the University liaison office has changed its name a number of times. First, it was the Research Grants and Contracts Office, which was later reorganized, leading to the establishment of the Office of Research Services. The latter was then reorganized on the recommendation of a review of the University's Presidential Advisory Committee on Campus Reviews and became the Intellectual Property and

Contracts Office and the Office of Research Grants. The 1992 task force that was mentioned in Chapter 4 did not comment on any specific structure, although in citing the Wisconsin Alumni Research Foundation (WARF) established in 1925 as a landmark in university-industry collaboration and a success story, the task force seemed to suggest that such a model, which is an arm's-length model, might be worth considering. In considering revisions to the structure, therefore, there is a need to examine the roles of the liaison office, of the faculties (deans' offices), and of the researchers. A central question to be addressed in such revision efforts concerns how the system could be made more effective and efficient?

Keeping Track of Records of Research and Development Activities

The University's Intellectual Property and Contracts Office had apparently not maintained records of which partnerships were initiated through their office, which were industry initiated, and which were university-researcher initiated. Such records would reveal where the initiative for most of these partnerships originated—from academia or from industry and what the trends were over time. What has emerged from the current study is that both sectors have taken the initiative, but data were not available to ascertain which sector provided the greater initiative. In this respect, the study has revealed the advantage of maintaining careful records of university-industry collaboration research activities.

Recommendations for Further Study

In the light of the findings from this study, the following recommendations are provided for further research.

The Relationship between Reward Structures and University-Industry Research and Development Partnerships

Reference was made to inadequate university reward structures in terms of the tenure and promotion of those involved in industry research. An example was given where

peer reviewed research publications were considered more important than research reviewed by industry research personnel. As noted earlier, the Natural Sciences and Engineering Research Council (NSERC) acknowledged this problem in its 1994 document, *Partnership in Knowledge: Maximizing the Investment in University Research,* when it stated that "university reward systems, especially for tenure and promotion, may have limiting impact on the activities undertaken by faculty researchers" and that NSERC "will encourage universities to give more recognition to outreach activities such as interaction with industry and professional associations" (p. 10). However, as was pointed out in chapter 6, one of the reasons for industry's search for university-industry research partnerships was the expertise of university researchers. The researchers with whom industry seeks to collaborate would most likely be well established in the profession. The question then would be: Do these university researchers owe their professional status to involvement in industry research, or has industry searched for them because they were already well established in their fields? This issue is further compounded by the fact that enhancement of one's academic profile was given by some of the university respondents as one of the reasons for involvement in university-industry research. If this is so then how can it be claimed that reward structures do not favor those involved in this type of research and development activity? Such questions call for an investigation of the status of university researchers who are involved in university-industry collaborative research and of the extent to which their involvement has helped to boost their academic profiles or has been a hindrance for them.

Further Study of Operational Structures

Two areas need to be explored regarding operational structures of university-industry partnerships. One of these is the decision making process and the other is model of liaison structure adopted for these linkages.

a) **Locus of decision-making.** Because some respondents from both the university and industry sectors were not satisfied with the decision-making process and

especially with the procedures associated with the establishment of research and development partnerships, and so complained about the long delays in decision-making due to too many layers of administration, there is a need for additional research to focus on this area. Questions to be explored include: Where should the locus of decision making be with regard to these research and development links? Should it be with the Intellectual Property and Contracts Office (now called Industry Liaison Office) or with the faculties or with the Vice-President (Research)? Also if any authority and decision-making are to be delegated, to whom should this responsibility be assigned?

b) Models of liaison offices: In-house model or arm's-length model? Some respondents from the university and industry made reference to their attraction for an arm's-length model of liaison offices rather than the in-house model with which they were dealing. Some wondered whether the arm's-length model might be better. It noted in Chapter 8 there are advantages and disadvantages associated with each of the models. A comparison of these different models might provide more insight as to which is better and under what circumstances. Further, a survey of these types of models across Canada and perhaps in other countries as to their operating characteristics and which are more prevalent, would be informative.

To What Extent Are Small Companies Affected by These Links?

Small firms felt the pressure of competition from large companies for university expertise. Some respondents from these companies felt that they could not compete with large firms because they did not have enough funds to attract university expertise. They argued that university researchers were more likely to go for "big bucks" that were offered by large corporations. This too suggests an area of research to determine the validity or otherwise of this contention and explore further the involvement of these small firms in university-industry research partnerships.

Separate Study of Centres and Institutes

There seems to be a proliferation of centres and institutes in universities. Some of these are involved with industrial research; others are not. Some are multidisciplinary; others are not. Some have connections with departments; others are autonomous. Some have more university research involvement; others have not. In view of these differences, a study of these centres and institutes, and especially of their role in university-industry research and development seems highly desirable.

Study of Opponents of University-Industry Research and Development

This study has provided the perspectives of participants in a number of areas pertaining to university-industry research and development partnerships. Although the presence of opponents of such partnerships within academia was acknowledged and noted, their perceptions were not obtained. A study that would explore their views and the reasons for these views would bring greater understanding of the problems such research partnerships efforts face.

Follow up Study Using Different Research Strategies

This study was designed and conducted as a qualitative study using an interpretive case study approach. The study identified a number of issues, including motivations, problems, challenges, and lessons and insights from the perspective of those involved in university-industry research and development links. No effort was made to determine how the participants prioritized the issues that were identified in terms of importance. A quantitative study using a larger sample could be designed to examine priorities and measure the degree of importance of some of the issues identified in the current study would be informative. The study could include more universities and industries than were considered in the present study.

Some Reflections

In this section, further reflections on some of the issues already noted and discussed in the preceeding sections are provided.

The Mission of the University and University-Industry Research and Development Partnerships

In the current study, based both in the interviews and the literature review, the university's involvement in research and development partnerships with industry has not been supported by everybody for the reasons that have been discussed. Whereas in the past universities were cautious about establishing such links, it seems that these collaborative research efforts are now accepted as part of the university's function. As one senior university administrator stated:

> We need to think of this industrial partnering as part of our academic mission; not separate from it, but part of it. . . . So I believe, whether we make money or not, and particularly because we are a publicly supported institution, we need to be playing a role in our community both locally and nationally, to help industry in developing commercializable technologies.

On the other hand, it is quite evident that some of these partnerships were motivated by funding, given the government cutbacks. Caution was expressed by some respondents in industry that universities should not seek these links under the illusion that they can make money. Some university researchers expressed similar concerns that university administration might be thinking on these same lines, seeing these research partnerships as alternative sources of funding. The financial element cannot be disputed as one of the reasons for engaging in these collaborations, but it may be overshadowing the other valid reasons provided for participation in research and development links with industry, such as a pure service function or curiosity to solve industrial problems. There is also the added dimension that governments and research funding agencies put pressure on the universities to pursue these kinds of activities. Recently, the issue of quality in university research programs has emerged as an area of interest. In this regard, the University document *Making Sense of Research at the University of Alberta* (1994) outlined a number of

research areas which have been rated as excellent vis-à-vis others outside and within the institution. It is not clear what the message is for those not listed or how they will react to the document. Further, the criteria for attaining "quality status" are not clear. Because different programs serve different clienteles, how does one compare a department in engineering with one in business, arts, Law or in education? It is important, therefore, that research and development partnerships, whose importance cannot be denied, not distort the other functions of the University of teaching and public service.

Attitudes, Communications, Dialogue and True Collaboration

Respondents from both sectors called for the development of more positive attitudes towards the other sector. Phrases such as "ivory tower," "rattling the professor in his cage," and "not selling oneself short to industry" seem to be an indication that to some degree suspicion about the motives of people in "the other sector". Issues such as "too much democracy" in the university and the view from industry that the university should operate like a business, among others, seem to suggest that industry has not fully understood what the nature of the university is. One industry respondent, for instance, quipped:

> The university structure as it is almost guarantees that there is no sense of direction for the university. It guarantees that everybody is going in a different direction. Business would never operate that way. You wouldn't run a business saying, "Okay, everybody run in a different direction, and we will hope we all get to the same place," because you will never get there.

The universities cannot be expected to operate like business where profit is the main motive. However, they should be efficient and effective in their operations.

Can the University Cope With Industry Demand for Research and Development Assistance?

One of the concerns expressed by an industry respondent was whether universities were prepared to meet the growing demand for research links with industry. It was based on the premise that interest in the area is developing; and given that scenario, were the

universities prepared to respond? It was noted in the study that a number of companies could not manage to accommodate the number of requests from universities for collaborative ventures and funding, a reflection that university researchers are taking the initiative. A clear picture of this demand on both sides was not possible because of the lack of statistical records; hence the need for both sectors to keep track of these records. On the other hand, a concern was expressed by one university respondent about the effect on teaching if researchers focused more time on research and development activities and delegated some of their teaching duties to sessional instructors. Clearly, whichever way one looks at the issue, it is one that each institution participating in these links will have to address.

Industry Presence within the University

The benefits of university-industry research and development have already been highlighted, but there was a sense of skepticism or uneasiness by some in industry of companies which have laboratory or rented space on campus. Some of these"on-campus companies" even have company names or sign boards. No one complained about a research institute being named after a company, but one complained of a research company's name being displayed in one of the premises. It seems that this is an area that can cause potential problems. What will happen if each company that has a research and development connection wishes to have its name displayed on campus? This would be acceptable in the external-model arrangement, but where a company lab exists alongside with an academic lab in the same building on campus, the arrangement may be a major source of uneasiness. One of the suggestions offered by one of the respondents to this problem is to have an incubator facility near the campus where most of these companies would be located. Some of the university respondents noted that the current industrial research park in the city is a bit far from campus. This is an area that may require further examination and decision by all the stakeholders in this area. However, it would seem that

a neutral ground near the campus where these campanies could be located is feasible solution rather than stationing them along side academic labs.

Student Involvement in University-Industry Research and Development Partnerships

Interviewees reported that graduate students benefit from research and development partnerships when they are involved in some of these research activities. Further, connections for future job opportunities arise as a result of student involvement in these projects. Some interviewees, however, lamented the lack of involvement of undergraduate students in these projects, save for cooperative education programs, which they lauded as a very valuable experience in industry. This sentiment needs special attention because involvement of both graduate and undergraduate students these research projects is likely to enhance their research skills which they can then utilize when they are employed by industry. Canadian industry has been criticized for being behind in research and development compared with that in other OECD countries. This observation was also made by some of the interviewees. Introducing the spirit of creativity and innovation at an earlier stage may be ultimately beneficial in preparing potential workers for the industrial work environment. Indeed, in a 1994 Faculty of Science Forum on Industry-University Interactions, a participant from industry, in a reference to Canadian universities, stated that "universities don't provide the right kind of training" for the industry work and research environment (Proceedings of the Faculty of Science Forum on Industry-University Interactions, 1994, p.7). However, the nature of these research and development partnerships as they exist may have to be modified to allow for the involvement of a greater number of students, and especially undergraduate students. Fairweather (1990) was right in pointing out that the educational element has been largely overlooked in these university-industry research and development partnerships.

Reflections on the Significance of the Study

What has emerged from this study is the array of mechanisms by which university researchers collaborate with industry in research and development activities. Institutes, centres, networks of centres of excellence, consortia, research contracts, and grants all merit special attention and further in-depth investigation. The University has been involved in research and development partnerships with industry over the years and appears to be building on that experience.

The experiences of those involved suggest that the initiating these research and development partnerships has not been easy. Establishing the partnerships in the first place was considered a challenge given the lack of awareness of the potential for collaboration in each of the sectors. Some respondents reported that university researchers send unsolicited project proposals to industries. Although such initiatives have to be lauded, they indicate an effective missing link between the two sectors. How are the university researchers to know which industries need research and development collaboration and vice versa? This is the reason that both sectors advocated the need for more marketing. These respondents apparently believed that this would bring about a higher level of awareness, thereby leading to more collaborations. Indeed, the level of awareness was emphasized as an important factor contributing to the enhancement of interorganizational relationships. However, the question of whose function it is to promote the level of awareness between the two sectors needs further examination.

Concluding Comments

This study sought to explore the nature of research and development partnerships between one university and industry, and the perceptions of those involved in these activities. The purpose was to develop a clear understanding of how these partnerships evolve and function and what kind of problems they face. It is evident that the number of

these partnerships has increased over the years and that many mechanisms exist for collaborative relationships. Several other findings deserve mention:

1) bureaucracy remains an obstacle to the establishment of these links;
2) researcher-to-researcher interaction is of utmost importance and should be encouraged;
3) stepping up marketing by both sectors is very important;
4) the degree of interest developed by industry and initiatives to search for integrated approaches to university links is growing;
5) the importance which industry attaches to fundamental research in universities should be a relief to those who have expressed concern that university - industry research and development links may emphasize applied research at the expense of fundamental research; and
6) the issue of intellectual property rights while still a contentious one seems amenable to resolution.

Interviewees from both sectors called for more dialogue, more interactions, and a more coordinated approach to policy governing research and development partnerships by governments, universities, and industry. However, each institution will still have to examine its research and development agenda based on its mission and strengths. The enthusiasm that was expressed by interviewees from both sectors augurs well for the future of these research and development links. Issues in this area will continue to emerge and be debated, and each institution will have to design its own plan for and approach to these links. No one has summarized and expressed this approach better than Blackman and Segal (1992), who stated:

> The debate will never be formally resolved at the generalized level....There is a huge institutional diversity within the higher education sector, within and across countries.... Further, whether or not industrial links have a distorting impact will depend on how each institution structures them. What limitations, if any, are put on the extent and the nature of academics' external involvement; and how are such sanctions put into effect? Conversely, what are the incentives, whether in terms of career progression or monetary gain, for academics to engage in external relationships?....All

> higher education institutions will have to find their own strategic responses that fit their particular sense of mission and their circumstances. (p. 946)

Indeed, the findings which have emerged from this study support what Blackman and Segal (1992) have stated. The onus then is on each institution to design strategic plans that will address their mission and circumstances. In this endeavor, all within academia, the proponents of and opponents to these links, as well as participants from industry should be involved in debates on this process. In the current study there was evidence of initiatives to involve industry in partnership discussions. However, as was noted, the voices of opponents were not heard, although their presence was acknowledged. Certainly, participation by all stakeholders in this area, both within academia and from outside, is a *sine qua non* of a successful university-industry partnership program that should withstand the test of time. The description given by one industry respondent of his company's research and development experience with universities underscores the importance of regular dialogue and working together, partnering, and collaborating on a regular basis in search of solutions to specified objectives:

> The lesson is that collaboration is important, for us to keep the dialogue going between universities; that without it benefits for both parties will not be as good; that we have to, as a company, understand the university environment, which I came from, but you have to be reminded that it is a creative environment, and it doesn't necessarily work on deadlines. If we collaborate with universities, I think we can solve a lot of problems in terms of keeping the programs in directions that are suitable for both parties, and to be able to bring that knowledge transfer in. I think that is just the key, which is why we as a company, as a management team, have said that collaboration is important.

Certainly, the tempo and the spirit of collaboration are there, and the potential for both sectors to benefit is immense. To what extent this will be exploited fully, only time will tell.

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APPENDIX 1

Interview Guide for Phase 1

1. How does your institution define or conceptualize university-industry linkages or partnerships?
2. What are or have been the motivations for your institution's establishment of research partnerships/linkages with the university/industry sector?
3. Explain the criteria and procedures for establishing these partnerships.
4. What structures has your institution established for the management and coordination of these research partnerships and how are they managed?
5. What have been the outcomes of these partnerships (How has your institution benefited from these research partnerships etc.)?
6. Explain your institution's policies regarding these partnerships? What government and university/industry policies exist now. How have these policies(your institution's and Government etc.) affected in any way the operation of these research partnerships.? What is your assessment of these policies?
7. Explain any problems that you have encountered in these research partnerships.
8. From your experiences and involvement with these corporate-university research partnerships, what lessons have you learned ?
9. What challenges do these partnerships face and how can they be enhanced and made made more effective?
10. How would you characterize the nature of the environment (internal and external) in which your institution and the partnerships in particular operate ?
11. Are there any other major points/issues/ concerns/suggestions that you have regarding these research partnerships that we may not have covered in our discussion.

APPENDIX 2

Interview Guide for Selected Partnerships (Phase 2)

Background (Needs and goals, motivations etc.)

1. When did this partnership start?
2. What factors (specific needs and goals etc.) led to the establishment of this partnership?

The Research Partnership Agreement

3. How was the agreement negotiated and what processes were used to finally agree on the ingredients of the agreement?
4. What are the main features/ingredients of the contract agreement for this partnership (objectives, funding arrangements, expected outcomes, responsibilities of the parties involved resource exchanges which characterize the linkage-funds, personnel, information, facilities etc.)?
5. How is this partnership organized, coordinated and managed?
6. From your experiences in this partnership/linkage what problems have you encountered or have been encountered by others in all the activities pertaining to this partnership?
7. Explain any other major concerns as an industry/ university researcher or administrator regarding this partnership?
8. What have been the benefits/successes and failures/shortcomings (negative and positive impacts)of this partnership?
9. What major challenges does this partnership face? (How might the current and future linkages be better organized, coordinated and managed in order to make them more effective?)
10. What lessons have you learned from your experiences in this partnership?
11. How would you characterize the nature of the environment (internal and external) in which your institution and this partnership in particular operate?

APPENDIX 3

Letter of Introduction

University of Alberta,
Department of Educational
Administration
7-104 Education Building North
Edmonton, Alberta
T6G 2G5

Dear_____

Re: Introduction to carry out research

I wish to introduce Mr. Joseph K. Koech, a doctoral student in our department who is conducting his research on "A case study of university-corporate partnerships and organizational challenges" under my supervision. The other members of the supervisory committee are Dr. E. Ratsoy, and Dr. C. R. James. Mr. Koech has already successfully defended his proposal and it has been approved by a University Ethics Review Committee, hence anonymity and confidentiality will be adhered to as and when required.

Mr. Koech will focus on research and development linkages and partnerships between the University of Alberta and the private sector. The study is divided into two phases: Phase 1 focuses on obtaining the general picture and pattern of these collaborations between the two sectors - the type of partnerships/linkages, characteristics of participating organizations, structures and processes, benefits, problems and challenges. Phase 2 will involve an in -depth study of a few of the selected partnerships. Mr. Koech will basically utilize interviews and documentary data as his main sources of information. Interviews will last about 60 minutes.

This letter is to request your assistance in this regard by accepting an interview with him and where possible by providing him with relevant documents as well as introducing him to other members of your organization who might assist him in this endeavor.

Mr. Koech will be in touch with you soon to discuss possible dates of interviews and other forms of assistance. Should you have any concerns or questions, please do not hesitate to contact me at 492-3651 . Thank you for your cooperation and I look forward to your continued assistance.

Yours sincerely,

Dr. James Small
Professor and Supervisor

c. Joseph Koech

APPENDIX 4

INFORMED CONSENT AGREEMENT FORM

This study entitled, " University-Corporate partnerships and organizational challenges", is conducted in accordance with the University of Alberta Guidelines on Ethics in Human Research and with the approval of the Department of Educational Administration Research Ethics Review committee. Participants in this study will be interviewed under the following conditions:

1. The interviewees will be fully informed about the nature and the purpose of the study.

2. The potential participants are under no obligation to be interviewed and their consent to participate is voluntary. They may withdraw from the study as their circumstances warrant.

3. Interviewees are guaranteed anonymity. If requested, names and identifying characteristics of the interviewees will be withheid, thereby guaranteeing anonymity. Names may also be changed to protect the identities of persons and places.

4. Interviews will be audio recorded and interviewees will be provided with the transcripts of their interview tapes to check for any errors and make any additions or deletions to ensure that the content accurately reflects the proceedings of the interview.

5. Permission of the interviewees to include any of their specific quotations in the final report of this study will be obtained.

If you agree to an interview under the above conditions, please indicate your agreement to participate in the study by signing the consent form below.

Signature----------

Date ----------